NASA SP–7037 (269)
September 1991

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(NASA-SP-7037(269)) AERONAUTICAL ENGINEERING: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 269) (NASA) 153 p
CSCL 01B
N92-10974
Unclas
00/01 0048218

NASA STI PROGRAM
SCIENTIFIC & TECHNICAL INFORMATION

NASA SP-7037 (269)
September 1991

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

National Aeronautics and Space Administration
Office of Management
Scientific and Technical Information Program
Washington, DC 1991

INTRODUCTION

This issue of *Aeronautical Engineering—A Continuing Bibliography* (NASA SP-7037) lists 539 reports, journal articles, and other documents originally announced in August 1991 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA).*

Accession numbers cited in this issue are:

STAR (N-10000 Series)	N91-23073 — N91-25099
IAA (A-10000 Series)	A91-36013 — A91-40566

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the publication consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged by the first nine *STAR* specific categories and the remaining *STAR* major categories. This arrangement offers the user the most advantageous breakdown for individual objectives. The citations include the original accession numbers from the respective announcement journals.

Seven indexes—subject, personal author, corporate source, foreign technology, contract number, report number, and accession number—are included.

A cumulative index for 1991 will be published in early 1992.

Information on availability of documents listed, addresses of organizations, and NTIS price schedules are located at the back of this issue.

PAGE ii INTENTIONALLY BLANK

CONTENTS

Category 01 Aeronautics (General) 611

Category 02 Aerodynamics 613
Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

Category 03 Air Transportation and Safety 634
Includes passenger and cargo air transport operations; and aircraft accidents.

Category 04 Aircraft Communications and Navigation 641
Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

Category 05 Aircraft Design, Testing and Performance 645
Includes aircraft simulation technology.

Category 06 Aircraft Instrumentation 655
Includes cockpit and cabin display devices; and flight instruments.

Category 07 Aircraft Propulsion and Power 656
Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxiliary power plants for aircraft.

Category 08 Aircraft Stability and Control 663
Includes aircraft handling qualities; piloting; flight controls; and autopilots.

Category 09 Research and Support Facilities (Air) 668
Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.

Category 10 Astronautics 669
Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; space communications, spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

Category 11 Chemistry and Materials 670
Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; propellants and fuels; and materials processing.

Category 12 Engineering 673
Includes engineering (general); communications and radar; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

PAGE iv INTENTIONALLY BLANK

Category 13 Geosciences 685
Includes geosciences (general); earth resources and remote sensing; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

Category 14 Life Sciences N.A.
Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and space biology.

Category 15 Mathematical and Computer Sciences 686
Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

Category 16 Physics 687
Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

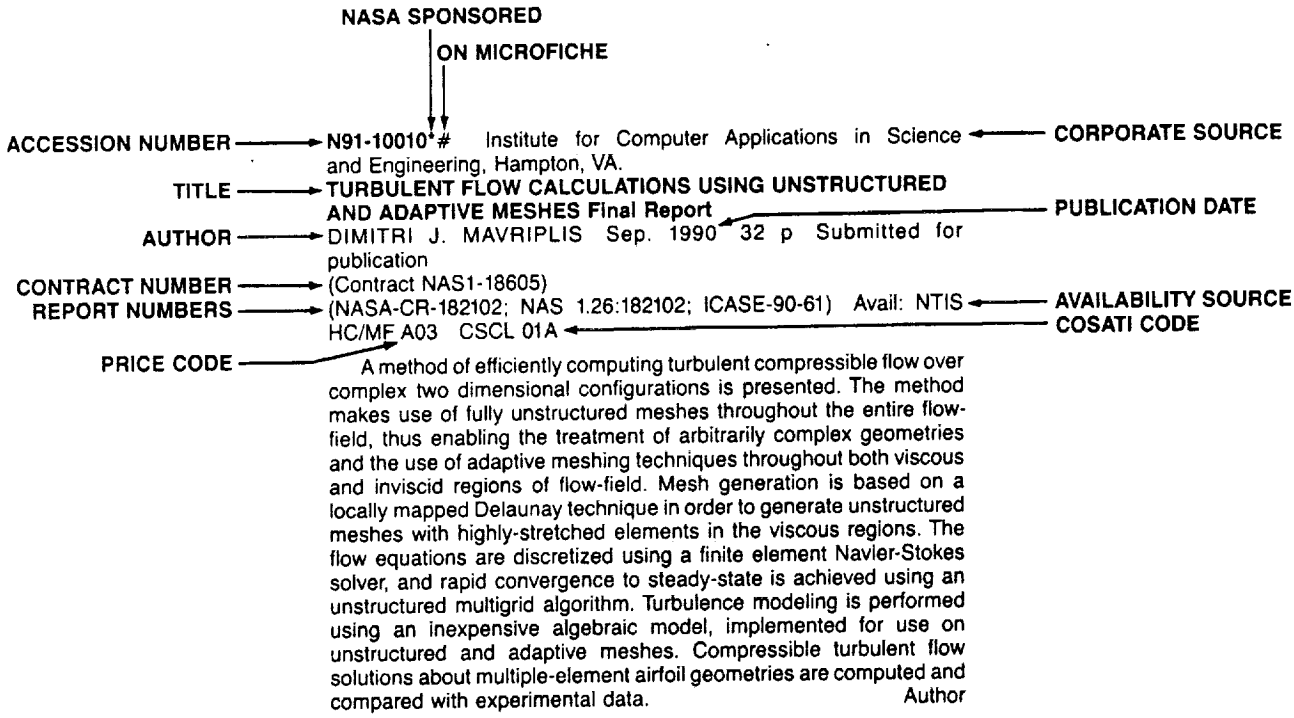
Category 17 Social Sciences 690
Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law, political science, and space policy; and urban technology and transportation.

Category 18 Space Sciences N.A.
Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.

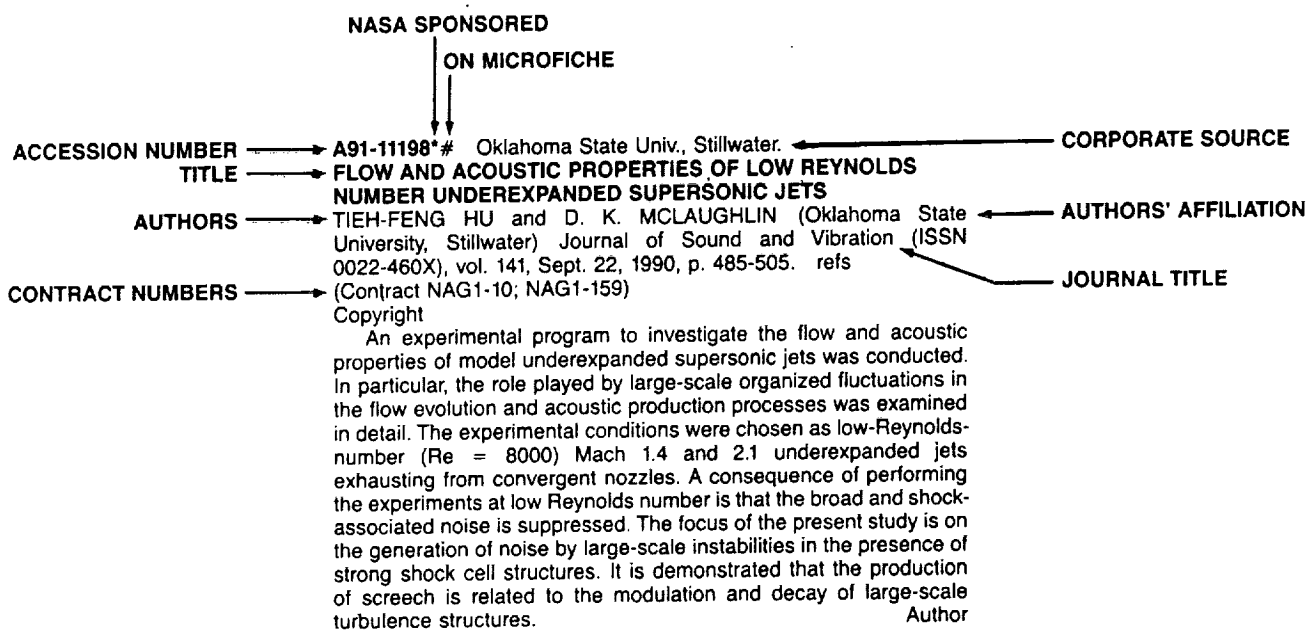
Category 19 General 691

Subject Index A-1
Personal Author Index B-1
Corporate Source Index C-1
Foreign Technology Index D-1
Contract Number Index E-1
Report Number Index F-1
Accession Number Index G-1
Appendix APP-1

TYPICAL REPORT CITATION AND ABSTRACT



TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT



AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 269)

SEPTEMBER 1991

01

AERONAUTICS (GENERAL)

A91-36351#
WRIGHT LABORATORY
ALAN S. BROWN (USAF, Wright Research and Development Center, Wright-Patterson AFB, OH) Aerospace America (ISSN 0740-722X), vol. 29, May 1991, p. 8-10.
Copyright

A review is presented of past and present aerospace research conducted at Wright Laboratory. Some of the advanced projects under study include turbines with twice the thrust/weight ratio of today's aircraft engines, flight helmets that reconstitute reality as a computer-enhanced simulation on their darkened inner walls, and hypersonic aircraft that fly from New York to Philadelphia in 90 seconds. The two major research programs being investigated are the National Aerospace Plane and the Integrated High-Performance Turbine Engine Technology effort, whose principal goal is to develop a flow of new technologies that can be integrated into turbine design. Attention is given to the research and development of composite materials and the important role they play in all of these advanced projects. R.E.P.

A91-36353#
LONG-RANGE AIRCRAFT ARE IN DEMAND
RICHARD DEMEIS Aerospace America (ISSN 0740-722X), vol. 29, May 1991, p. 24-27, 31.
Copyright

The overriding technological combinations that must be developed to provide for increased payload/long-range efficiency in commercial aircraft are discussed. The many requirements include: lighter structures, fuel efficiency, available engine thrust at optimum cruise altitude, and the relationship of lift, drag, and engine fuel efficiency to produce the greatest range when drag divided by speed is kept to a minimum. Attention is given to the various new ultra-high-bypass turbofans under development that approach the 100,000 lb thrust category with bypass ratios of better than 20/1. R.E.P.

A91-36875
METAL MATRIX COMPOSITE VERTICAL TAIL FABRICATION
DAVID M. GINBURG (Lockheed Aeronautical Systems Co., Marietta, GA) Society of Manufacturing Engineers, Metal Matrix Clinic Conference, Anaheim, CA, Nov. 13, 14, 1990. 20 p.
(SME PAPER EM90-438) Copyright

Four full-scale Metal-Matrix Composite (MMC) vertical tails were built from two types of MMC: 15v/o SiC(w)/2124-T6 Al, and SiC/6061 Al. Fabrication of the detail parts used several unique, cost-effective processes. The greatest labor-saving device was the robotic abrasive waterjet used to cut the flat patterns. Flanged ribs were formed by hot-rubber hydroforming, replacing matched dies with a single male form block. The large laminated SiC(w)Al skins were chemically milled and adhesive-bonded. All fabrication and assembly operations were performed in accordance with production-rate process standards and instructions. Author

A91-36895
AUTOMATIC AIRCRAFT PAINT STRIPPING
VERNON R. STURDIVANT (Southwest Research Institute, San Antonio, TX) Society of Manufacturing Engineers, Conference on Aerospace Automation and Fastening, Arlington, TX, Oct. 9-11, 1990. 12 p.
(Contract F33615-86-C-5044)
(SME PAPER MS90-280) Copyright

Paint must be removed from aircraft to allow detailed surface inspection, to perform repair operations, and to keep weight at acceptable levels after many coats of paint have been applied. Southwest Research Institute is presently constructing a robotic system for automatically removing paint from fighter aircraft for the United States Air Force. The process removes paint by plastic media bead blasting. The blast nozzles are positioned over the aircraft surface with a robot. The system consists of two, 9 degree-of-freedom (DOF) robots together with two robot controllers, one cell control computer, paint sensors, and bead blasting equipment. Author

A91-36898
THE INTRODUCTION OF OFF-LINE PROGRAMMING TECHNIQUES FOR THE ROBOTIC ASSEMBLY OF AIRCRAFT STRUCTURES
JOHN R. THOMPSON (British Aerospace /Military Aircraft/, Ltd., Blackburn, England) Society of Manufacturing Engineers, Conference on Aerospace Automation and Fastening, Arlington, TX, Oct. 9-11, 1990. 25 p. refs
(SME PAPER MS90-276) Copyright

A system is described for off-line programming a robot performing assembly operations where interaction and coordination between peripheral devices is essential for correct operation. The complex nature of automated assembly operations requires multidevices to assemble and fasten components together. As part of British Aerospace's on-going commitment to automated assembly development, this paper discusses the introduction of a robotic off-line programming method which uses a CAD database to construct device part programs. A 3-D computer simulation system models and animates all the programmable motions in the physical automated assembly cell. Once tape proved an off-line program is produced incorporating calibration methods. Author

A91-36944
AIRCRAFT REPAIR/GENERAL AVIATION QUICK TOOLING
FRED BANKE (Composite Craft, Inc., Orlando, FL) Society of Manufacturing Engineers, Conference on Tooling for Composites '90, Anaheim, CA, June 5-7, 1990. 20 p.
(SME PAPER EM90-178) Copyright

It is often required that a damaged component be returned to its original contours and aerodynamic smoothness on site. Sound, efficient in-field composite repair techniques are necessary to effect such repairs. This paper summarizes some approaches taken to the in-field repair mold concept and the resultant findings. Author

A91-37061#
CAPP IMITATIVE SYSTEM OF AIRCRAFT ASSEMBLY
GONGFAN SHE and HUASHOU QIU (Northwestern Polytechnical University, Xian, People's Republic of China) Northwestern

Polytechnical University, Journal (ISSN 1000-2758), vol. 9, April 1991, p. 240-245. In Chinese, with abstract in English.

A rule-based 'imitative' expert system for computer-aided process planning (CAPP) is proposed which can serve as the Chinese aircraft industry's bridge between CAD and CAM processes' implementation. The imitative CAPP employs the AI language TURBO-PROLOG to conduct simple and easily modifiable modular programming; simplicity levels are in fact such as to allow microcomputer CAPP implementation. The modules in question address data inputs, tooling and assembly, operation sequence arrangement, and specifications editing. Attention is presently given to CAPP's description-related data. O.C.

A91-38546#
AIRCRAFT DESIGN FOR MAINTAINABILITY
ANTHONY E. MAJOROS (Douglas Aircraft Co., Long Beach, CA) Journal of Aircraft (ISSN 0021-8669), vol. 28, March 1991, p. 187-192. Previously cited in issue 21, p. 3248, Accession no. A89-49459. refs
Copyright

A91-38580*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AERONAUTICAL RESEARCH IN THE UNITED STATES - CHALLENGES FOR THE 1990'S
RICHARD H. PETERSEN and BRUCE J. HOLMES (NASA, Langley Research Center, Hampton, VA) DGLR, Annual Meeting, Friedrichshafen, Federal Republic of Germany, Oct. 1-4, 1990, Paper. 12 p. refs

An overview is presented of NASA R&D initiatives in air transportation technologies that will dominate its efforts through the 1990s. These efforts are to be concentrated in (1) advanced subsonic transports with greater fuel economy, passenger capacity, and control effectiveness, whose design will be undertaken with state-of-the-art CFD and CAD/CAM systems; (2) a second-generation SST whose propulsion system will be substantially more fuel-efficient than that of Concorde and have far lower atmospheric emissions; and (3) a hypersonic transport predicated on the results of research into materials, cryogenic fuels, propulsion cycles, and propulsion/airframe aerodynamics integration, which will be undertaken in connection with the X-30 testbed. O.C.

A91-39392
THE TECHNICAL CHALLENGES OF THE CREW ESCAPE TECHNOLOGIES PROGRAM
EDWARD O. ROBERTS (USAF, Human Systems Div., Wright-Patterson AFB, OH) IN: Annual SAFE Symposium, 27th, New Orleans, LA, Dec. 5-8, 1989, Proceedings. Newhall, CA, SAFE Association, 1990, p. 170-175. refs
Copyright

Some of the technical challenges of the Crew Escape Technologies (CREST) program that are inherent in developing a true 700-KEAS open-ejection-seat capability are discussed, and some insight is provided into the complex job of integrating all of the various subsystem components into a workable system. These challenges include the design, construction, and testing of an open ejection seat with a 'safe' ejection up to 700 KEAS; increased performance over the baseline ACES-II, or 'third-generation', seat; the design of a seat system that will tailor its linear and angular acceleration performance to human tolerance criteria that are defined in terms of injury-risk limits; and the development of the appropriate control-system software. Results from a performance comparison of various types of crew-escape technologies (catapult test, axial head lift force, and longitudinal head force) are presented in graphs. P.D.

A91-39852
COMPOSITES FOR A WIDEBODY
FRANK COLUCCI Aerospace Composites and Materials (ISSN 0954-5832), vol. 3, May-June 1991, p. 22-24.
Copyright

A review is presented of the composite material technology that has been applied to the development and construction of the wide-bodied MD-11 commercial transport aircraft. It is shown that composites promise fatigue lives two to three times greater than metal, and DC-10 aileron access doors, trailing edge panels, and floor beams and struts all demonstrated the fatigue and corrosion resistance inherent in the new materials. Safety-of-flight structures are developed to handle ultimate loads with undetectable damage and limit loads with easily detectable damage. Advanced stitched spars and stringers can resist interlaminar tension loads in future primary structure, and high modulus toughened thermosets can open new composite design opportunities. R.E.P.

A91-39854
MOULDED MUSTANG
FRANK COLUCCI Aerospace Composites and Materials (ISSN 0954-5832), vol. 3, May-June 1991, p. 40, 41, 43.
Copyright

A project to market full-scale composite replicas of the P-51 is presented that has already produced large high-temperature composite tools to mould Mustang kits for racing and recreational pilots. The teardrop shape, compound curve design of the fuselage lends itself particularly well to composite moulding. It is expected that the composite aircraft will weigh 3,200 to 3,500 lb empty, compared to the 7,800 to 11,000 lb weight empty of the metal original. Details of the composite moulding technique are described along with tooling and materials involved. Engine selection has not been finalized, however, several liquid-cooled candidates from offshore racing boats are under consideration. R.E.P.

A91-40180
TILTROTOR DEVELOPMENTS
ICAO Journal (ISSN 0018-8778), vol. 46, Feb. 1991, p. 6-10.
Copyright

The present evaluation of the technology-development requirements and commercial viability of tiltrotor VTOL aircraft of V-22 size and larger gives attention to the technical changes needed by the civilian version of the V-22 and the commuter market anticipated for the movement of passengers from small airports to airline hub airports. It is noted that the elimination of various military structural features from the V-22 will substantially reduce gross takeoff weight or allow a less expensive metallic, rather than all-composite, fuselage to be employed. High developmental priority is given in the present study to noise-reduction technology and design features, such as higher blade-number rotors. O.C.

A91-40181
MODIFICATION MEETS CHAPTER 3 STANDARDS
WALTER H. JOHNSON (Valsan, Purchase, NY) ICAO Journal (ISSN 0018-8778), vol. 46, Feb. 1991, p. 16, 17.
Copyright

Airport vicinity noise-reduction legislation, in conjunction with higher fuel prices and slower growth in global air traffic, have enhanced the economic viability of reenginings for such older airliners as the B 727s presently discussed. A 1990 certification for the reengined 727-100s discussed established noise levels 9 dB lower than ICAO chapter 3 levels, while reducing operating costs and increasing flight performance. The reengining replaces the port and starboard engines with JT8D-217Cs, and acoustically treats the existing central engine. O.C.

A91-40563#
SAFETY OF AGING AIRCRAFT - BOEING PROGRAMS FOR THE 1990'S
P. J. HARRADINE and M. MILLER (Boeing Commercial Airplanes, Seattle, WA) AIAA, ASME, ASCE, AHS, and ASC, Structures, Structural Dynamics and Materials Conference, 32nd, Baltimore, MD, Apr. 8-10, 1991. 11 p.
(AIAA PAPER 91-0909) Copyright

An overview is presented of historical and current aging aircraft activities, efforts anticipated for aircraft models in production, and how the knowledge gained and lessons learned will be incorporated into future designs. It is shown how industry and airworthiness

authorities have collaborated to develop and implement major new programs involving structural modifications, corrosion prevention and control, and the damage tolerance of structural repairs. Consideration is also given to awareness and training programs, including a course to acquaint key airline maintenance and FAA personnel with the requirements and the procedures of the newly mandated Corrosion Prevention and Control Program. R.E.P.

N91-23076# Institute for Defense Analyses, Alexandria, VA.
THE COSTS AND BENEFITS OF AIRCRAFT AVAILABILITY Final Report, Jan. - Sep. 1990
MATTHEW S. GOLDBERG and KAREN W. TYSON Mar. 1991 45 p
(AD-A232660; AD-E501359; IDA-P-2462; IDA/HQ-90-35834)
Avail: NTIS HC/MF A03 CSCL 01/2

This paper contains estimates of the effects of research and development costs (through initial operational capability) and unit procurement costs on the mission-capable (MC) rates of eleven tactical aircraft models. These estimates are transformed into estimates of the marginal cost of increasing MC rates through, respectively, increased development or increased procurement expenditures. The benefits of higher MC rates are also computed. One benefit is that, with more reliable aircraft, the procurement quantity may be reduced. A second benefit is that more reliable aircraft have lower operations and maintenance (O and M) costs in the field. The magnitudes of these effects are also estimated. Finally, the costs and benefits are combined to compute optimal levels of investment in reliability, both for hypothetical aircraft models and for the eleven aircraft models used in the statistical analysis. GRA

N91-23077# Institute for Defense Analyses, Alexandria, VA.
ESTIMATING FIXED AND VARIABLE COSTS OF AIRFRAME MANUFACTURERS Final Report, Dec. 1988 - Dec. 1990
STEPHEN J. BALUT, THOMAS P. FRAZIER, and JAMES BUI Mar. 1991 42 p
(AD-A232661; AD-E501360; IDA-P-2401; IDA/HQ-90-35536)
Avail: NTIS HC/MF A03 CSCL 05/3

This report presents a model for separating annual costs at airframe manufacturing plants into fixed and variable components. The use of the model is to aid defense analysts in estimating the cost to manufacture aircraft systems when the manufacturer has not yet been determined or when proprietary models for the specific firms are not available. The material is unclassified and non-proprietary. GRA

N91-24087# Wichita State Univ., KS. National Inst. for Aviation Research.
KANSAS AVIATION REVIEW
FLOYD PRICE, ed. 1991 45 p The 5th Annual Kansas State Aviation Conference was held in Liberal, KS, 14-16 Sep. 1990
(NIAR-91-3) Avail: NTIS HC/MF A03

The purpose of the Review is to provide a multi-disciplinary aviation publication opportunity. Topics addressed include: automated inspection of aging aircraft; secondary certification in aerospace education; cognitive performance in cockpits; information resources in aviation; demand for college aviation programs.

N91-24088# Wichita State Univ., KS.
EVALUATION OF AUTOMATION FOR INSPECTION OF AGING AIRCRAFT
BEHNAM BAHR *In its* Kansas Aviation Review p 1-8 1991
Avail: NTIS HC/MF A03

A new automated/robotics system or a potential system for aircraft inspection is described. In order to develop a semi-automated or robotics system for the inspection of an aircraft, several facts need to be considered. Therefore, a set of criteria are prepared that will enable any interested party to make an appropriate response as to what type of system should be supported or bought. These issues may involve not only the selection of what mechanism is the best system but also if additional training will be required to implement the automated inspection. Author

N91-24093# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
SOME ANALYSIS OF DECISION-MAKING IN THE TEST MANUFACTURE OF MILITARY AIRCRAFT
RUOSONG WANG 29 Nov. 1990 14 p Transl. into ENGLISH from Guoji Hangkong (Peoples Rep. of China), no. 319, Sep. 1989 p 23-24
(AD-A233111; FTD-ID(RS)T-0716-90) Avail: NTIS HC/MF A03 CSCL 01/2

Modern military aircraft are complex engineering systems. They include target or object systems, operating systems, as well as related structural systems. They form a large, complicated engineering system made up from natural systems and social systems. As far as the goodness or badness, the success of failure of this type of engineering is concerned, it is not simply a matter of one industry; one cannot even stop with a consideration of the aviation industry of one nation; it extends even to the nation as a whole. All these things are important factors. This type of engineering requires long periods of time. The technology is complicated and new. It has enormous consequences. In addition to this, the whole world is paying careful attention to it. As a result of this, its influence involves economic effects, military effects, and political consequences. GRA

N91-24160# Wichita State Univ., KS.
BONDED/FUSION REPAIR OF AIRCRAFT STRUCTURES
WAYNE BECKER and JAMES HO *In its* Program Plans for Aviation Safety Research 6 p Dec. 1990
Avail: NTIS HC/MF A04

The objective is to quantify a procedure for assessment and repair of aircraft metallic and composite structures which will provide reliable, consistent results with minimal downtime. The technical approach and project management and coordination are briefly discussed. Author

N91-24163# Wichita State Univ., KS.
MECHANICAL PAINT REMOVAL TECHNIQUES FOR COMPOSITE AIRCRAFT
JORGE E. TALIA, BEHNAM BAHR, WAYNE BECKER, and HAMID M. LANKARANI *In its* Program Plans for Aviation Safety Research 6 p Dec. 1990
Avail: NTIS HC/MF A04

The use of conventional paint removal on composite material can lead to a fast deterioration or weakening of the material due to the absorption and chemical attack of the solvent which may result in a catastrophic failure of the structure. Moreover, recent EPA regulations ban the use of solvents for paint removal on land and sea military bases. The objective is to investigate the possibilities of paint removal by mechanical techniques, specifically by the impingement of solid particles, a technique that would not leave structural damage on the treated material and would not effect the environment. Author

02

AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

A91-36359
UNSTEADY, FREQUENCY-DOMAIN ANALYSIS OF HELICOPTER NON-ROTATING LIFTING SURFACES
OLYMPIO A. F. MELLO and OMRI RAND (Maryland, University, College Park) American Helicopter Society, Journal (ISSN 0002-8711), vol. 36, April 1991, p. 70-81. refs
Copyright

A model for predicting the unsteady periodic loads acting on non-rotating helicopter lifting surfaces is derived. Lifting surfaces and their wakes are represented by bound, trailing, and shed vortices that account for the involved unsteady effects. Rotor blades are represented by bound vortices having prescribed spanwise and azimuthal strength distributions. Rotor wake is modeled by helical tip vortices of varying strength. Assuming periodic behavior, the overall governing equations are formulated in terms of Fourier coefficients. Consequently, no time discretization is used, thus permitting a single step numerical procedure while all the unsteady effects are consistently included. The method is shown to give an insight to the problem and to be an appropriate tool for predicting unsteady characteristics of the lifting surfaces and the related vibratory loads, along with their sensitivity to helicopter design parameters. Correlations with existing experimental results are presented. Author

A91-36452* New Jersey Inst. of Tech., Newark.
THE STABILITY TO TWO-DIMENSIONAL WAKES AND SHEAR LAYERS AT HIGH MACH NUMBERS
DEMETRIOS T. PAPAGEORGIOU (New Jersey Institute of Technology, Newark) Physics of Fluids A (ISSN 0899-8213), vol. 3, pt. 1, May 1991, p. 793-802. refs
(Contract NAS1-18605)
Copyright

This study is concerned with the stability properties of laminar free-shear-layer flows, and in particular symmetric two-dimensional wakes, for the supersonic through the hypersonic regimes. Emphasis is given to the use of proper wake profiles that satisfy the equations of motion at high Reynolds numbers. In particular the inviscid stability of a developing two-dimensional wake is studied as it accelerates at the trailing edge of a splitter plate. The nonparallelism of the flow is a leading-order effect in the calculation of the basic state, which is obtained numerically. Neutral stability characteristics are computed and the hypersonic stability is obtained by increasing the Mach number. It is found that the stability characteristics are altered significantly as the wake develops. Multiple modes (secondary modes) are found in the near wake that are closely related to the corresponding Blasius ones, but as the wake develops mode multiplicity is delayed to higher and higher Mach numbers. At a distance of about one plate length from the trailing edge, there is only one mode in a Mach number range of 0-20. The dominant mode emerging at all wake stations, and for high enough Mach numbers, is the so-called vorticity mode that is centered around the generalized inflection point layer. The structure of the dominant mode is also obtained analytically for all streamwise wake locations and it is shown how the far-wake limit is approached. Asymptotic results for the hypersonic mixing layer given by a tanh and a Lock distribution are also given. Author

A91-36453* High Technology Corp., Hampton, VA.
REAL GAS EFFECTS ON HYPERSONIC BOUNDARY-LAYER STABILITY
M. R. MALIK (High Technology Corp., Hampton, VA) and E. C. ANDERSON (NASA, Langley Research Center, Hampton, VA) Physics of Fluids A (ISSN 0899-8213), vol. 3, pt. 1, May 1991, p. 803-821. refs
Copyright

High-temperature effects alter the physical and transport properties of a gas, air in particular, due to vibrational excitation and gas dissociation, and thus the chemical reactions have to be considered in order to compute the flow field. Linear stability of high-temperature boundary layers is investigated under the assumption of chemical equilibrium and this gas model is labeled here as real gas model. In this model, the system of stability equations remains of the same order as for the perfect gas and the effect of chemical reactions is introduced only through mean flow and gas property variations. Calculations are performed for Mach 10 and 15 boundary layers and the results indicate that real gas effects cause the first mode instability to stabilize while the second mode is made more unstable. It is also found that the second mode instability shifts to lower frequencies. There is a slight destabilizing influence of real gas on the Goertler instability as compared to the perfect gas results. Author

A91-36695#
ON THE IMPROVEMENT OF THE SUPERSONIC LIFTING LINE THEORY
I. JADIC (Institutul National pentru Creatie Stiintifica si Tehnica, Bucharest, Rumania) Revue Roumaine des Sciences Techniques, Serie de Mecanique Appliquee (ISSN 0035-4074), vol. 35, Mar.-Apr. 1990, p. 75-88. refs

Two errors associated with the lifting line theory for supersonic linearized flows are pointed out. The first error results from the assumption of the constant chord distribution of vortices and can be corrected by correlating the control point position with the aspect ratio. The second error is related to the possibility of information transfer beyond the inverse Mach cone limit. This error is dealt with by using simple conical flow solutions whenever possible. The improved lifting line theory is validated by comparisons with the available theoretical and experimental data. V.L.

A91-36699#
NEW METHODS IN THE THEORY OF SUBSONIC FLOWS PAST THIN AIRFOIL CONFIGURATIONS
L. DRAGOS (Bucharest, University, Rumania) Revue Roumaine des Sciences Techniques, Serie de Mecanique Appliquee (ISSN 0035-4074), vol. 35, May-June 1990, p. 179-196. refs

The fundamental solution method is used to obtain integral equations of subsonic flow past various airfoil configurations, including identical or symmetrical airfoils in parallel, cascades, and different airfoils in tandem. By using Gaussian quadrature formulas, the integral equations are reduced to algebraic systems that can be readily programmed on a computer. Numerical results are presented for flat plates. V.L.

A91-36700#
WING CALCULATION IN SUPERSONIC FLOW BY MEANS OF THE SUPERSONIC LIFTING LINE THEORY
I. JADIC (Institutul National pentru Creatie Stiintifica si Tehnica, Bucharest, Rumania) Revue Roumaine des Sciences Techniques, Serie de Mecanique Appliquee (ISSN 0035-4074), vol. 35, May-June 1990, p. 197-208. refs

An improved version of the supersonic lifting line theory, SLLT + C, is assessed by way of comparison with the available theoretical and experimental data. The cases considered include straight, triangular, and swept wings. The predictions of the theory correlate well with test data for conventional planforms. It is concluded that the improved supersonic lifting line theory provides useful approximations of the aerodynamic characteristics of wings without excessive errors even for Mach numbers close to 1. V.L.

A91-36724#
AERODYNAMIC CALCULATION OF TANDEM WINGS IN SUPERSONIC FLOW BY MEANS OF SLLT
I. JADIC (Institutul National pentru Creatie Stiintifica si Tehnica, Bucharest, Rumania) Revue Roumaine des Sciences Techniques, Serie de Mecanique Appliquee (ISSN 0035-4074), vol. 35, July-Aug. 1990, p. 309-324. refs

An improved supersonic lifting line theory (SLLT) is used to calculate wing-tail interference for tandem wings. In contrast to previous, approaches, the loading on the wing is calculated by the lifting line procedure itself. The results obtained show that the accuracy of the proposed method is consistent with the linearized theory, making it possible to calculate the downwash with a moderate computational effort. L.M.

A91-37176
DISCONTINUOUS SOLUTIONS FOR A THREE-DIMENSIONAL HYPERSONIC BOUNDARY LAYER WITH INTERACTION [O RAZRYVNYKH RESHENIIAKH PROSTRANSTVENNOGO GIPERZVUKOVOGO POGRANICHNOGO SLOIA SO VZAIMODEISTVIEM]

V. V. MAKHAN'KOV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), Mar.-Apr. 1991, p. 19-26. In Russian. refs
Copyright

Three-dimensional flow of a viscous gas in a hypersonic boundary layer on a flat wing with a steplike leading edge is analyzed in the case where the boundary layer interacts with a slightly deflected flap on the wing. A linear solution to the problem is obtained assuming that the flap deflection angle is small and the difference of the plate lengths is of the order of one. It is shown that the formation of flow near the flap is determined to a large degree by pressure changes along the wing span due to the stepped shape of the leading edge. Although the displacement pressure and thickness are continuous functions of the transverse coordinates, the longitudinal and transverse components of the friction force become discontinuous. V.L.

A91-37181
ENTROPY EFFECTS OF HYPERSONIC FLOW PAST BLUNT DELTA WINGS [ENTROPIINYE EFFEKTY GIPERZVUKOVOGO OBTEKANIIA ZATUPLENNYKH TREUGOL'NYKH KRYL'EV]
S. A. GOROKHOV, V. V. EREMIN, and A. M. POLIAKOV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), Mar.-Apr. 1991, p. 178-181. In Russian. refs
Copyright

Hypersonic flow past blunt delta wings is investigated analytically. It is shown that, for large wing spans, extreme flow regimes with essentially nonuniform gasdynamic parameters may realize in the shock layer at the windward wing surface. Flow patterns on the wing surface are determined for a wing with an angle of sweep of 75 degrees. For the same wing, the ranges of Mach numbers and angles of attack are determined which correspond to extreme flow conditions. V.L.

A91-37418#
MACH 4 TESTING OF SCRAMJET INLET MODELS
TEKASHI KANDA, TOMOYUKI KOMURO, GORO MASUYA, KENJI KUDO, ATSUO MURAKAMI (National Aerospace Laboratory, Kakuda, Japan) et al. Journal of Propulsion and Power (ISSN 0748-4658), vol. 7, Mar.-Apr. 1991, p. 275-280. Previously cited in issue 20, p. 3083, Accession no. A89-47010. refs
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A91-37419#
THREE-DIMENSIONAL FINITE ELEMENT METHOD ANALYSIS OF TURBULENT FLOW OVER SELF-PROPELLED SLENDER BODIES
RUSSELL H. THOMAS, JOSEPH A. SCHETZ (Virginia Polytechnic Institute and State University, Blacksburg), and DOMINIQUE H. PELLETIER (Ecole Polytechnique, Montreal, Canada) Journal of Propulsion and Power (ISSN 0748-4658), vol. 7, Mar.-Apr. 1991, p. 281-287. U.S. Navy-supported research. Previously cited in issue 18, p. 2996, Accession no. A88-44753. refs
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A91-37420#
EXPERIMENTAL INVESTIGATION OF LOADING EFFECTS ON COMPRESSOR TRAILING-EDGE FLOWFIELDS
DUANE C. MCCORMICK, ROBERT W. PATERSON (United Technologies Research Center, East Hartford, CT), and HARRIS D. WEINGOLD (Pratt and Whitney Commercial Engine Business, East Hartford, CT) Journal of Propulsion and Power (ISSN 0748-4658), vol. 7, Mar.-Apr. 1991, p. 288-296. Previously cited in issue 07, p. 934, Accession no. A88-22267. refs
(Contract N00014-83-C-0434)
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A91-37421*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
COMPUTATIONAL ANALYSIS OF UNDEREXPANDED JETS IN THE HYPERSONIC REGIME
ANDREW T. HSU (NASA, Lewis Research Center; Sverdrup Technology, Inc., Cleveland, OH) and MENG-SING LIOU (NASA, Lewis Research Center, Cleveland, OH) Journal of Propulsion and Power (ISSN 0748-4658), vol. 7, Mar.-Apr. 1991, p. 297-299. Previously cited in issue 21, p. 3483, Accession no. A88-50604. refs
Copyright

A91-37767#
FORWARD SWEEP - A FAVORABLE CONCEPT FOR A LAMINAR FLOW WING
G. REDEKER and G. WICHMANN (DLR, Institut fuer Entwurfsaerodynamik, Brunswick, Federal Republic of Germany) Journal of Aircraft (ISSN 0021-8669), vol. 28, Feb. 1991, p. 97-103. Previously cited in issue 22, p. 3634, Accession no. A88-51938. refs
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A91-37768#
MOVING SURFACE BOUNDARY-LAYER CONTROL AS APPLIED TO TWO-DIMENSIONAL AIRFOILS
V. J. MODI, F. MOKHTARIAN, M. S. U. K. FERNANDO (British Columbia, University, Vancouver, Canada), and T. YOKOMIZO (Kanto Gakuin University, Yokohama, Japan) Journal of Aircraft (ISSN 0021-8669), vol. 28, Feb. 1991, p. 104-112. Previously cited in issue 09, p. 1277, Accession no. A89-25253. refs
(Contract NSERC-A-2181)
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A91-37769*# Oklahoma Univ., Norman.
PERFORMANCE OF AN AEROSPACE PLANE PROPULSION NOZZLE
GEORGE EMANUEL (Oklahoma, University, Norman) and YOON-YEONG BAE Journal of Aircraft (ISSN 0021-8669), vol. 28, Feb. 1991, p. 113-122. Previously cited in issue 18, p. 2758, Accession no. A89-42103. refs
(Contract NAG1-886)
Copyright

A91-37770*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EFFECT OF EXHAUST PLUME/AFTERBODY INTERACTION ON INSTALLED SCRAMJET PERFORMANCE
T. A. EDWARDS (NASA, Ames Research Center, Moffett Field, CA) Journal of Aircraft (ISSN 0021-8669), vol. 28, Feb. 1991, p. 123-130. Previously cited in issue 09, p. 1271, Accession no. A89-25028. refs
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A91-37772#
ACT WIND-TUNNEL EXPERIMENTS OF A TRANSPORT-TYPE WING
T. UEDA, H. MATSUSHITA, S. SUZUKI, and Y. MIYAZAWA (National Aerospace Laboratory, Chofu, Japan) (ICAS, Congress, 16th, Jerusalem, Israel, Aug. 28-Sept. 2, 1988, Proceedings. Volume 1, p. 194-204) Journal of Aircraft (ISSN 0021-8669), vol. 28, Feb. 1991, p. 139-145. Previously cited in issue 03, p. 256, Accession no. A89-13525. refs
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A91-37777#
AERODYNAMIC CHARACTERISTICS OF SLENDER WING-GAP-BODY COMBINATIONS
YUZO YAMAMOTO (Gifu National College of Technology, Japan), SHIGENORI ANDO (Nagoya University, Japan), and KAZUO MIKI (Toyota Central Research and Development Laboratories, Inc., Aichi, Japan) Japan Society for Aeronautical and Space Sciences, Transactions (ISSN 0549-3811), vol. 33, Feb. 1991, p. 154-175. refs

The aerodynamic characteristics of the slender wing-gap-body combinations are studied exactly within the frame of the slender body aerodynamic theory. Solutions are presented for slender configurations, in which the wings and the body have different incidences with respect to the free stream and arbitrary width chordwise gaps exist between the wings and the body. The expressions of the aerodynamic forces derived originally by Ward

(1949) and the relations between the complex velocity and a downwash on the body are extended to the case of multiply-connected cross sections. The most practical cases encountered by missile aerodynamicists may be covered, and the basic lift results agree with those obtained by Dugan and Hikido (1954). Author

A91-37780#
A COMPARISON BETWEEN COMPUTATION AND EXPERIMENT FOR FLOWS AROUND AIRFOIL WITH SLAT AND FLAP
MICHIRU YASUHARA, YOSHIAKI NAKAMURA, and WEI JIA (Nagoya University, Japan) Japan Society for Aeronautical and Space Sciences, Transactions (ISSN 0549-3811), vol. 33, Feb. 1991, p. 218-233. refs

The flows about an airfoil with a slat and a flap are investigated experimentally and numerically. The experiment measures aerodynamic coefficients and velocity distributions in the neighborhood of the slat slot exit and visualizes the flow field for various attack angles and flap angles, which include two cases: open and closed slat slot. The Reynolds number of the experiments is 160,000. A numerical simulation is conducted under the same conditions as the experiment, and comparison between experiment and calculation shows good agreement for aerodynamic coefficients, flow patterns, and velocity distributions, especially in the region influenced by the slat slot jet. Control of a flow separation by the jet is significant for improving the flow situation around an airfoil at large attack angles. Author

A91-37827*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ASYMMETRIC VORTICES ON A SLENDER BODY OF REVOLUTION
G. G. ZILLIAC, D. DEGANI, and M. TOBAK (NASA, Ames Research Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol. 29, May 1991, p. 667-675. Previously cited in issue 08, p. 1102, Accession no. A90-22211. refs
Copyright

A91-37829*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INTERACTIVE THREE-DIMENSIONAL BOUNDARY-LAYER METHOD FOR TRANSONIC FLOW OVER SWEPT WINGS
SHAWN H. WOODSON, JAMES F. CAMPBELL (NASA, Langley Research Center, Hampton, VA), and FRED R. DEJARNETTE (North Carolina State University, Raleigh) AIAA Journal (ISSN 0001-1452), vol. 29, May 1991, p. 678, 679. Abridged. Previously cited in issue 09, p. 1272, Accession no. A89-25099. refs
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A91-37830#
STRUCTURE OF THE COMPRESSIBLE TURBULENT SHEAR LAYER
DIMITRI PAPAMOSCHOU (California Institute of Technology, Pasadena) AIAA Journal (ISSN 0001-1452), vol. 29, May 1991, p. 680, 681. Abridged. Research supported by Rockwell International Foundation. Previously cited in issue 09, p. 1273, Accession no. A89-25111.
(Contract N00014-85-K-0646)
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A91-37832#
VARIABLE-PROPERTY EFFECTS IN SUPERSONIC WEDGE FLOW
A. POZZI (Napoli, Universita, Naples, Italy) and M. LUPO AIAA Journal (ISSN 0001-1452), vol. 29, May 1991, p. 686, 687. Abridged.
Copyright

A study is presented on the variable-property effects on supersonic flow along a wedge, taking into account wall thermal resistance. The axis of the wedge is maintained either at a constant temperature or under adiabatic conditions. Viscosity and thermal conductivity coefficients are assumed to depend on temperature in a polynomial form. The problem governed by the isothermal condition on the axis does not admit similarity solutions and is solved by using two expansions, an initial one and an asymptotic one. The solution of the second problem can be obtained in similarity form. A discussion of the variable-property effects and the influence of thermal resistance of the wall on the Nusselt number friction coefficient, and temperature at the wall, for several values of the Mach number, ends the paper. Author

A91-37835#
NUMERICAL STUDY OF HYPERSONIC DISSOCIATED AIR PAST BLUNT BODIES
ESWAR JOSYULA and JOSEPH S. SHANGE (USAF, Wright Research and Development Center, Wright-Patterson AFB, OH) AIAA Journal (ISSN 0001-1452), vol. 29, May 1991, p. 704-711. refs

Nonequilibrium hypersonic flows past axisymmetric blunt bodies at zero incidence have been numerically simulated by the Navier-Stokes equations with finite-rate dissociation for both noncatalytic and fully catalytic surfaces. The high-temperature air mixture was described by the nonequilibrium Lighthill's dissociation gas model including the equilibrium vibrational excitation of diatomic gas molecules. The numerical results reproduced the detailed physics and the rate of heat transfer in the stagnation region, which agreed very well with the classic theories and experimental measurements. The limiting form of the governing equations used at the axis of symmetry alleviated the numerical bulge error that was frequently encountered for the axisymmetric blunt-body problem. Author

A91-37836#
BLOCK MULTIGRID IMPLICIT SOLUTION OF THE EULER EQUATIONS OF COMPRESSIBLE FLUID FLOW
YORAM YADLIN and DAVID A. CAUGHEY (Cornell University, Ithaca, NY) AIAA Journal (ISSN 0001-1452), vol. 29, May 1991, p. 712-719. Research supported by McDonnell Douglas Corp. and U.S. Army. Previously cited in issue 06, p. 754, Accession no. A90-19684. refs
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A91-37838#
UNSTEADY WAVE STRUCTURE NEAR SEPARATION IN A MACH 5 COMPRESSION RAMP INTERACTION
DAVID S. DOLLING (Texas, University, Austin) and MEHMET E. ERENGIL AIAA Journal (ISSN 0001-1452), vol. 29, May 1991, p. 728-735. refs
(Contract AF-AFOSR-86-0112)
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Fluctuating wall-pressure measurements have been made under the unsteady separation shock and the separated shear layer in a Mach 5 compression ramp-induced turbulent interaction. The freestream unit Reynolds number was 49.6 million/m and the turbulent boundary layer developed on the tunnel floor under approximately adiabatic wall-temperature conditions. Conditional sampling and 'variable-window' ensemble-averaging techniques have been used to determine ensemble-averaged pressure distributions for different separation shock-wave positions. The results show that (1) the region in which the separation shock foot translates is characterized by a compression system whose strength is a function of the separation shock position; (2) ensemble-averaged wall-pressure distributions for 'shock-upstream' and 'shock-downstream' conditions are characteristic of large- and small-scale separated flows, respectively, indicative of an expanding and contracting bubble; and (3) ensemble-averaged wall-pressure histories under the separated shear layer rise and fall as the separation shock translates downstream and upstream, respectively. Author

A91-37841*# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH.
THREE-DIMENSIONAL COMPOSITE VELOCITY SOLUTIONS FOR SUBSONIC/TRANSONIC FLOW
RAYMOND E. GORDNIER (USAF, Wright Aeronautical

Laboratories, Wright-Patterson AFB, OH) and STANLEY G. RUBIN (Cincinnati, University, OH) AIAA Journal (ISSN 0001-1452), vol. 29, May 1991, p. 750-757. Previously cited in issue 18, p. 2755, Accession no. A89-42065. refs
(Contract F49620-85-C-0027; NAG1-8)

A91-37842# Texas Univ., Arlington.
INCEPTION LENGTH TO A FULLY DEVELOPED, FIN-GENERATED, SHOCK-WAVE, BOUNDARY-LAYER INTERACTION
FRANK K. LU (Texas, University, Arlington) and GARY S. SETTLES (Pennsylvania State University, University Park) AIAA Journal (ISSN 0001-1452), vol. 29, May 1991, p. 758-762. Previously cited in issue 18, p. 2757, Accession no. A89-42078. refs
(Contract AF-AFOSR-86-0082; NCA2-192; NAG1-891)
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A91-37859#
FOREBODY VORTEX CONTROL WITH THE UNSTEADY BLEED TECHNIQUE
D. R. WILLIAMS (Illinois Institute of Technology, Chicago) and H. PAPAZIAN AIAA Journal (ISSN 0001-1452), vol. 29, May 1991, p. 853-855.
(Contract F49620-86-C-0133)
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The asymmetric vortex systems generated by aircraft and missile forebodies at high angles of attack create powerful yaw moments that can overwhelm control surfaces. Attention is presently given to the unsteady base bleed technique for Karman vortex street formation control without the use of external appendages; it is shown that this technique can be used to change the asymmetrix flow around a cone-cylinder model at high angles of attack to a symmetric state. Flow visualization verifications of this symmetrization effect are presented and analyzed. O.C.

A91-38541#
NUMERICAL INVESTIGATION OF AIRFOIL/JET/FUSELAGE-UNDERSURFACE FLOWFIELDS IN GROUND EFFECT
C. J. HWANG (National Cheng Kung University, Tainan, Republic of China), S. Y. YANG, and J. L. LIU Journal of Aircraft (ISSN 0021-8669), vol. 28, March 1991, p. 161, 162. Abridged. Previously cited in issue 06, p. 760, Accession no. A90-19939. refs
Copyright

A91-38544*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
CALCULATION OF STEADY AND UNSTEADY PRESSURES ON WINGS AT SUPERSONIC SPEEDS WITH A TRANSONIC SMALL-DISTURBANCE CODE
ROBERT M. BENNETT, SAMUEL R. BLAND, JOHN T. BATINA (NASA, Langley Research Center, Hampton, VA), MICHAEL D. GIBBONS (Lockheed Engineering and Sciences Co., Hampton, VA), and DENNIS G. MABEY (Royal Aerospace Establishment, Bedford, England) (Structures, Structural Dynamics and Materials Conference, 28th, Monterey, CA, Apr. 6-8, 1987 and AIAA Dynamics Specialists Conference, Monterey, CA, Apr. 9, 10, 1987, Technical Papers. Part 2A, p. 363-377) Journal of Aircraft (ISSN 0021-8669), vol. 28, March 1991, p. 175-180. Previously cited in issue 14, p. 2102, Accession no. A87-33691. refs
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A91-38545#
TIP VORTEX/AIRFOIL INTERACTION FOR A LOW REYNOLDS NUMBER CANARD/WING CONFIGURATION
F. A. KHAN (Boeing Commercial Airplanes Co., Seattle, WA) and T. J. MUELLER (Notre Dame, University, IN) Journal of Aircraft (ISSN 0021-8669), vol. 28, March 1991, p. 181-186. Research supported by University of Notre Dame. Previously cited in issue 09, p. 1283, Accession no. A89-25430. refs
(Contract N00014-83-K-0239)
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A91-38677
DYNAMIC STALL OF AN OSCILLATING CIRCULATION CONTROL AIRFOIL
G. D. SHREWSBURY and L. N. SANKAR (Georgia Institute of Technology, Atlanta) IN: International Symposium on Nonsteady Fluid Dynamics, Toronto, Canada, June 4-7, 1990, Proceedings. New York, American Society of Mechanical Engineers, 1990, p. 15-22. refs
Copyright
A two-dimensional, time-accurate Navier-Stokes analysis method has been used to evaluate the dynamic airloads of a circulation control airfoil. Numerical data were acquired for a mean angle of attack of 4.0 degrees and pitching amplitudes of 2.0 and 4.0 degrees. Reduced frequencies of 0.100 and 0.300 were evaluated. For higher values of reduced frequency, dynamic stall produces a complex bimodal characteristic for the aerodynamic load coefficient histories at both values of pitching amplitude. At the lower values of pitching amplitude and reduced frequency, a multiple stall characteristic is observed. At the lower value of reduced frequency and a pitching amplitude of 4.0 degrees, the pitching cycle produces a single loop characteristic, similar to that observed for conventional airfoils, except that the dynamic stall is not nearly as abrupt, and occurs over a much greater portion of the cycle. Author

A91-38679
UNSTEADY FLOW PAST AN AIRFOIL PITCHED AT CONSTANT RATE
C. SHIH, L. LOURENCO, L. VAN DOMMELEN, and A. KROTHAPALLI (Florida Agricultural and Mechanical University; Florida State University, Tallahassee) IN: International Symposium on Nonsteady Fluid Dynamics, Toronto, Canada, June 4-7, 1990, Proceedings. New York, American Society of Mechanical Engineers, 1990, p. 41-50. USAF-supported research. refs
Copyright
The particle image displacement velocimetry technique is used to investigate in a water towing tank the unsteady flow plast a NACA 0012 airfoil that is undergoing a constant-rate pitching up motion. The original technique is capable of providing, with great detail and accuracy, the instantaneous two-dimensional velocity and associated vorticity fields. Noticeable leading edge flow separation develops when alpha is greater than 20 deg, as a result of the local imbalance between vorticity generation and convection. The development of the leading edge vortex dominates the later flow behavior. Complete stall occurs after this vortex detaches from the airfoil and triggers the shedding of a counterrotating vortex near the trailing edge. A parallel computer simulation of the Navier-Stokes equations using a discrete vortex, random walk scheme is conducted, the global flow features predicted by the computation comparing well with the experiment. P.D.

A91-38680* Stanford Univ., CA.
UNSTEADY AERODYNAMIC LOADING OF DELTA WINGS FOR LOW AND HIGH ANGLES OF ATTACK
H. ASHLEY, T. VANECK (Stanford University, CA), M. A. M. JARRAH (Jordan University of Science and Technology, Irbid), and J. KATZ (San Diego Sate University, CA) IN: International Symposium on Nonsteady Fluid Dynamics, Toronto, Canada, June 4-7, 1990, Proceedings. New York, American Society of Mechanical Engineers, 1990, p. 61-78. refs
(Contract NCC2-596; NCA2-287; AF-AFOSR-84-0099)
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Experimental and theoretical investigations dealing with unsteady flow phenomena are surveyed, with the emphasis on the pattern of vortices which originate from flow separation at sharp leading edges. It is concluded that these vortices exhibit quasi-steady behavior when the alpha-vibrations are such that bursting instability does not occur above the wing surface. A selection of test results from Jarrah (1988) is presented and discussed. For sharp-edged delta models at low speeds, the aerodynamic loads which are plotted quantify the role of parameters AR and K for three ranges of alpha-variation. An extremely

approximate and empirical 'theory' is offered, with data on crossflow drag and burst location, to reproduce the behavior of these airloads up to 90 deg. Recent attempts to apply the more sophisticated tools of computational fluid dynamics to the combination of unsteadiness and very high alpha are shown to be deficient.
P.D.

A91-38681
COMPUTATION OF AXISYMMETRIC SLENDER BODIES ENCLOSING A JET EFFLUX IN PITCHING OSCILLATORY MOTION
M. H. LIN and M. J. SHEU (National Tsing Hua University, Hsinchu, Republic of China) IN: International Symposium on Nonsteady Fluid Dynamics, Toronto, Canada, June 4-7, 1990, Proceedings. New York, American Society of Mechanical Engineers, 1990, p. 79-86. refs
Copyright
A numerical method based on vortex lattice technique is developed to analyze the flow around an axisymmetric ogive-cylinder or ellipsoid-cylinder body, enclosing a jet efflux from the nozzle exit, undergoing harmonic pitching motion. When the body oscillates, the unsteady component of the circulation around the body changes with time. According to the Kelvin's circulation theorem, the total circulation around the oscillatory body must show up as shed vorticity in the wake. It is assumed that this shed vorticity is convected downstream along the body surface to infinity with the local velocity. Results of unsteady pressure distributions, lift and pitching moment for slender body undergoing a simple harmonic pitching oscillation are presented for a range of frequency parameters and several jet mass flow rates in order to study the influence of the frequency parameter, mean angle of incidence and jet mass flow rate on the aerodynamic properties.
Author

A91-38683* Old Dominion Univ., Norfolk, VA.
NUMERICAL SIMULATION OF STEADY AND UNSTEADY ASYMMETRIC VORTICAL FLOW
O. A. KANDIL, T.-C. WONG (Old Dominion University, Norfolk, VA), and C. H. LIU (NASA, Langley Research Center, Hampton, VA) IN: International Symposium on Nonsteady Fluid Dynamics, Toronto, Canada, June 4-7, 1990, Proceedings. New York, American Society of Mechanical Engineers, 1990, p. 99-108. refs
(Contract NAS1-18584)
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The unsteady, compressible, thin-layer, Navier-Stokes equations are solved to simulate steady and unsteady, asymmetric, vortical laminar flow around cones at high incidences and supersonic Mach numbers. The equations are solved by using an implicit, upwind, flux-difference splitting, finite-volume scheme. Locally conical flows are assumed and the solutions are obtained by forcing the conserved components of the flowfield vector to be equal at two axial stations located at 0.95 and 1.0. Computational examples cover steady and unsteady asymmetric flows around a circular cone and its control using side strakes. Unsteady asymmetric flows are also presented for elliptic- and diamond-section cones, which model asymmetric vortex shedding around round and sharp-edged delta wing flows.
Author

A91-38684* Jordan Univ. of Science and Technology, Irbid.
VISUALIZATION OF THE FLOW ABOUT A DELTA WING MANEUVERING IN PITCH TO VERY HIGH ANGLE OF ATTACK
M. A. M. JARRAH (Jordan University of Science and Technology, Irbid) IN: International Symposium on Nonsteady Fluid Dynamics, Toronto, Canada, June 4-7, 1990, Proceedings. New York, American Society of Mechanical Engineers, 1990, p. 109-116. refs
(Contract AF-AFOSR-84-0099; NCA2-287)
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An experimental program of unsteady aerodynamic measurements has been carried out in one of the 7 ft by 10 ft low-speed wind tunnels at NASA Ames Research Center. Flow-visualization measurements on a delta wing model of AR = 1.0 with sharp leading edges were carried out by means of a thin planar sheet of laser light fixed in the test section at a convenient angle to the flow direction. Smoke images of the fluid motion and vortex structure above the model were recorded photographically and later analyzed to determine such information as the positions of the cores and occurrence of bursting. Large amplitude transient motion involving post stall angle of attack excursions produced significant hysteresis in the vortex burst location and was reflected in the measured aerodynamic loads.
Author

A91-38686
ON SOME PHYSICAL ASPECTS OF AIRFOIL DYNAMIC STALL
M. R. VISBAL (USAF, Wright Research and Development Center, Wright-Patterson AFB, OH) IN: International Symposium on Nonsteady Fluid Dynamics, Toronto, Canada, June 4-7, 1990, Proceedings. New York, American Society of Mechanical Engineers, 1990, p. 127-147. refs
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A discussion is presented concerning various physical aspects of the dynamic stall process of a two-dimensional pitching airfoil. The dynamic stall flow features are described for the case of laminar and turbulent conditions separately. Emphasis is given to the unsteady flow field structure during dynamic stall vortex formation. A discussion of the effects of pitch rate, pitch-axis location and compressibility on the stall process is also included.
Author

A91-38694
UNSTEADY SEPARATION ON AN IMPULSIVELY SET INTO MOTION CARAFOLI AIRFOIL
J. C. WILLIAMS, III and C.-G. CHEN (Auburn University, AL) IN: International Symposium on Nonsteady Fluid Dynamics, Toronto, Canada, June 4-7, 1990, Proceedings. New York, American Society of Mechanical Engineers, 1990, p. 291-301. Cray Research, Inc.-supported research. refs
Copyright
The effects of both body thickness and trailing edge radius on the development of unsteady separation on bodies impulsively set into motion are determined. The boundary layer development is calculated on a series of Carafoli airfoils with varying body thickness ratio and trailing edge radius. Computations show that as time progresses, the skin friction passes through zero and becomes negative on the rear portion of the airfoil while the displacement thickness and displacement velocity each have strong local maxima away from the trailing edge. These characteristics indicate that separation will occur spontaneously away from the rear stagnation point. The main effect of making the body thinner and/or reducing the trailing edge radius is movement of the local maximum in the displacement thickness, the local maximum in the displacement velocity, and the region of reverse flow toward the rear stagnation point. It is concluded that reducing the body thickness or trailing edge radius moves the separation point toward the rear stagnation point.
P.D.

A91-38695
A NEW SYSTEM FOR UNSTEADY AERODYNAMICS OF MOVING WALL
C. MARESCA, D. FAVIER, and J. BELLEUDY (Institut de Mecanique des Fluides, Marseille, France) IN: International Symposium on Nonsteady Fluid Dynamics, Toronto, Canada, June 4-7, 1990, Proceedings. New York, American Society of Mechanical Engineers, 1990, p. 303-310. refs
(Contract DRET-87-272)
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This paper describes the development of a new laser-Doppler anemometry technique, suited for unsteady boundary-layer measurements around a moving model. The measurement principle is based on an LDA optical fiber option using an optical head embedded inside the moving model. Instantaneous velocity profiles and boundary-layer characteristics are obtained in a reference frame linked with the motion of the model. The acquisition procedure and data reduction techniques are described and applied to the flow around a flat plate either at rest in the steady flow or

oscillating in fore-and-aft motion. Details of the steady and unsteady boundary-layer measurements are presented at different longitudinal distances along the plate. Unsteady boundary-layer measurements on the oscillating plate are also compared to existing experimental and calculated results obtained on a fixed model positioned in oscillatory flow. Author

A91-38699
DEEP STALL OF AN NACA 0012 AIRFOIL INDUCED BY PERIODIC AERODYNAMIC INTERFERENCE
J. M. PHILLIPS (USAF, Wright-Patterson AFB, OH), C. M. VACZY (General Electric Co., Lynn, MA), and E. E. COVERT (MIT, Cambridge, MA) IN: International Symposium on Nonsteady Fluid Dynamics, Toronto, Canada, June 4-7, 1990, Proceedings. New York, American Society of Mechanical Engineers, 1990, p. 339-350. Research supported by USAF and MIT. refs
(Contract N00014-85-K-0513)
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An experiment was conducted to measure the deep stall surface pressure distribution on a stationary NACA 0012 airfoil in an unsteady flow field. Tests were conducted at Reynolds numbers of 125,000, 400,000 700,000, and 1,000,000, and at six half-chord reduced frequencies between 0.5 and 6.4. Airfoil angle of attack was varied from 0 to 18 deg, although only 10 deg (or greater) are important here. The pressure disturbance is modeled using a single or combination of convected single point vortices. Author

A91-38702
UNSTEADY PRESSURE FLUCTUATION ON A HIGHLY LOADED TURBINE BLADE ROW
S. H. CHEN, A. H. EASTLAND, and J. L. BOYNTON (Rockwell International Corp., Rocketdyne Div., Canoga Park, CA) IN: International Symposium on Nonsteady Fluid Dynamics, Toronto, Canada, June 4-7, 1990, Proceedings. New York, American Society of Mechanical Engineers, 1990, p. 369-375. refs
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A two-dimensional frequency domain source-doublet based potential paneling formulation is used to simulate the unsteady velocity and pressure fluctuation on a high loading turbine stator blade row due to blade-wake interaction. The wake profile developed by Lakshminarayana is employed here as the upstream wake which moves relative to the blades. The results show that a high fluctuating pressure occurred near the trailing edge with an amplitude many times of the inlet velocity head. In addition, the unsteady torsional moment is high. In this paper, the method of frequency domain computation and the cause of high dynamic pressure near the trailing edge of a high loading turbine stator vane are discussed. Author

A91-38710
HIGH SUBSONIC FLOW ABOUT A MOVING SPOILER IDENTIFYING A NOVEL PROBLEM OF WIND TUNNEL INTERFERENCE
S. AHMED and G. J. HANCOCK (Queen Mary College and Westfield College, London, England) IN: International Symposium on Nonsteady Fluid Dynamics, Toronto, Canada, June 4-7, 1990, Proceedings. New York, American Society of Mechanical Engineers, 1990, p. 477-486. refs
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A two-dimensional spoiler on a transonic tunnel floor is rotated from 0 deg to 45 deg in the order of 0.005 s over a range of subsonic Mach numbers. Transient pressures are measured on the tunnel floor in front of, and behind of, the spoiler. Physical explanations are given for this transient pressure behavior. In these experiments, initial transient flow responses about the spoiler settle down to an asymptotic steady state before the overall flow in the tunnel has time to respond. A novel problem is encountered at high Mach number. During the initial transient response, although static pressures far upstream of the spoiler change due to forward propagation of compression waves, the static pressures far downstream of the spoiler remain constant. Reasons for this phenomenon are still being sought. Author

A91-38736* Illinois Univ., Urbana.
NUMERICAL STUDY OF TWIN-JET IMPINGEMENT UPWASH FLOW
W. J. PEGUES and S. P. VANKA (Illinois, University, Urbana) IN: Forum on Turbulent Flows - 1990; Joint CSME/ASME Spring Meeting, Toronto, Canada, June 4-7, 1990, Proceedings. New York, American Society of Mechanical Engineers, 1990, p. 97-103. NASA-supported research. refs
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Two horizontally spaced jets impinging normally on a flat surface create a fountain upwash flow due to the collision of the radially flowing wall jets. This fountain flow is of importance to the dynamics and propulsion of STOVL aircraft. The fountain flow influences the lift forces on the aircraft and the ingestion of hot gases and debris by the engine inlet. In this paper, a multigrid based finite-difference numerical procedure has been applied to solve the equations governing this three-dimensional flow. The standard k-epsilon turbulence model has been used. Comparisons with experimental data reveal that while the mean velocities are predicted with reasonable accuracy, the turbulent kinetic energies are seriously in error. The reasons for this discrepancy could be the intense unsteadiness and large-scale structures of the flow in the near-wall region, which cannot be captured well by any Reynolds-averaged turbulence model. Author

A91-38742
STEADY FLOW IN A THREE-DIMENSIONAL RECTANGULAR CAVITY YAWED FROM THE FREESTREAM TURBULENT BOUNDARY LAYER
R. G. DIMICCO and P. J. DISIMILE (Cincinnati, University, OH) IN: Forum on Turbulent Flows - 1990; Joint CSME/ASME Spring Meeting, Toronto, Canada, June 4-7, 1990, Proceedings. New York, American Society of Mechanical Engineers, 1990, p. 169-174. refs
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The nature of the flow phenomena produced within a three-dimensional rectangular cavity immersed in and yawed from the approaching low-speed turbulent boundary layer is examined. The steady pressure distributions in both the streamwise and spanwise directions are explored. The experiment was conducted in air at a nominal freestream velocity of 2.4 m/s with a corresponding Reynolds number, based on the cavity width, of 9951. The centerline and spanwise pressure distributions on the cavity floor compare well with past investigations. The spanwise 'cell' structure within the cavity is severely affected by the cavity rotation and leads to the growth of the upstream cell and compression of its downsteam counterpart. P.D.

A91-38787
A SIMPLIFIED AEROTHERMAL HEATING METHOD FOR AXISYMMETRIC BLUNT BODIES
J. B. KOUROUPIS (Johns Hopkins University, Laurel, MD) IN: Heat transfer in space systems; Proceedings of the Symposium, AIAA/ASME Thermophysics and Heat Transfer Conference, Seattle, WA, June 18-20, 1990. New York, American Society of Mechanical Engineers, 1990, p. 49-53. refs
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A simple procedure has been developed for use on a personal computer to calculate aerothermal heating of axisymmetric blunt bodies at angle of attack (AOA). Heating rates are correlated from boundary layer edge conditions, thermodynamically defined along the body using entropy and surface pressure. Surface pressure is calculated using a unique variation of the tangent cone method. Variable entropy at the boundary layer edge (due to curvature of the bow shock) is accounted for using a mass-balancing procedure. Streamline spreading for angle of attack cases is determined with a simplified axisymmetric analog technique. The present method is simpler than other hypersonic convective heating codes because it does not require a computational fluid dynamics flow field solution (either viscous or inviscid). The method predicts laminar and turbulent heating rates within 20 percent (usually within 10 percent) of experimental data,

except for the leeward ray, in flows with freestream Mach 2-15 and incidence angles up to 30 deg. Author

A91-39048*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
TEMPORALLY AND SPATIALLY RESOLVED FLOW IN A TWO-STAGE AXIAL COMPRESSOR. II - COMPUTATIONAL ASSESSMENT
K. L. GUNDY-BURLET, M. M. RAI (NASA, Ames Research Center, Moffett Field, CA), R. C. STAUTER, and R. P. DRING (United Technologies Research Center, East Hartford, CT) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X), vol. 113, April 1991, p. 227-232. Previously announced in STAR as N90-14236. refs
(ASME PAPER 90-GT-299) Copyright

Fluid dynamics of turbomachines are complicated due to aerodynamic interactions between rotors and stators. It is necessary to understand the aerodynamics associated with these interactions in order to design turbomachines that are both light and compact as well as reliable and efficient. The current study uses an unsteady, thin-layer Navier-Stokes zonal approach to investigate the unsteady aerodyamics of a multistage compressor. Relative motion between rotors and stators is made possible by use of systems of patched and overlaid grids. Results have been computed for a 2 1/2-stage compressor configuration. The numerical data compares well with experimental data for surface pressures and wake data. In addition, the effect of grid refinement on the solution is studied. Author

A91-39223
STEADY LINEARISED AERODYNAMICS. III - TRANSONIC
D. HOMENTCOVSCHI (Polytechnic Institute, Bucharest, Rumania) Archiwum Mechaniki Stosowanej (ISSN 0373-2029), vol. 42, no. 1, 1990, p. 3-18. refs
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The application of the integral equation method to the study of steady transonic flow of inviscid fluid past an aerofoil is discussed. For the three-dimensional nonplanar aerofoil, the problem is reduced to that of solving a system of two singular nonlinear integral equations. In the plane case an integral equation is obtained whose kernel is expressed in terms of elementary functions only. Author

A91-39691#
A MODEL FOR THE EXPERIMENTAL STUDY OF CURVATURE EFFECTS ON TRANSITION OF THE BOUNDARY LAYER ON A SWEPT WING - PRELIMINARY RESULTS
H. PEERHOSSAINI (Nantes, Universite, France), H. BIPPES (DLR, Institut fuer experimentelle Stroemungsmechanik, Goettingen, Federal Republic of Germany), and D. STEINBACH (DLR, Institut fuer theoretische Stroemungsmechanik, Goettingen, Federal Republic of Germany) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 6, 1990, p. 15-21. DLR-supported research. refs
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A new concave-convex model has been designed and constructed to study the combined effect of curvature and sweep on a three-dimensional boundary layer. The preliminary results show that in swept boundary layer, spanwise variation of the streamwise velocity (due to the Goertler instability) is suppressed. These results agree with recent theoretical analysis of this problem. Author

A91-39708
ROTARY OSCILLATION CONTROL OF A CYLINDER WAKE
P. T. TOKUMARU and P. E. DIMOTAKIS (California Institute of Technology, Pasadena) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 224, March 1991, p. 77-90. refs
(Contract F49620-86-C-0134)
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Exploratory experiments have been performed on circular cylinders executing forced rotary oscillations in a steady uniform flow. Flow visualization and wake profile measurements at moderate Reynolds numbers have shown that a considerable amount of control can be exerted over the structure of the wake by such means. In particular, a large increase, or decrease, in the resulting displacement thickness, estimated cylinder drag, and associated mixing with the free stream can be achieved, depending on the frequency and amplitude of oscillation. Author

A91-39736* Tel-Aviv Univ. (Israel).
SECONDARY FREQUENCIES IN THE WAKE OF A CIRCULAR CYLINDER WITH VORTEX SHEDDING
SAUL S. ABARBANEL (Tel Aviv University, Israel), WAI SUN DON, DAVID GOTTLIEB (Brown University, Providence, RI), DAVID H. RUDY, and JAMES C. TOWNSEND (NASA, Langley Research Center, Hampton, VA) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 225, April 1991, p. 557-574. DARPA-supported research. Previously announced in STAR as N90-22540. refs
(Contract NAS1-18107; NAS1-18605; N00014-86-K-0754; AF-ARFOSR-90-0093; NSF DMS-88-10150)
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A detailed numerical study of two-dimensional flow past a circular cylinder at moderately low Reynolds numbers was conducted using three different numerical algorithms for solving the time-dependent compressible Navier-Stokes equations. It was found that if the algorithm and associated boundary conditions were consistent and stable, then the major features of the unsteady wake were well-predicted. However, it was also found that even stable and consistent boundary conditions could introduce additional periodic phenomena reminiscent of the type seen in previous wind-tunnel experiments. However, these additional frequencies were eliminated by formulating the boundary conditions in terms of the characteristic variables. An analysis based on a simplified model provides an explanation for this behavior. Author

A91-39738
FURTHER EXPERIMENTS ON VORTEX FORMATION AROUND AN OSCILLATING AND TRANSLATING AIRFOIL AT LARGE INCIDENCES
KAZUO OHMI (Osaka University, Japan), MADELEINE COUTANCEAU (Poitiers, Universite, France), OLIVIER DAUBE, and TA P. LOC (CNRS, Laboratoire d'Informatique pour la Mecanique et les Sciences de l'Ingenieur, Orsay, France) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 225, April 1991, p. 607-630. DRET-supported research. refs
Copyright

The starting flows past a two-dimensional NACA 0012 airfoil translating and oscillating at large incidences are investigated by visualization experiments and numerical calculations. The airfoil model is set in motion impulsively and subjected simultaneously to a constant translation and harmonic oscillation in pitch. The evolution of the vortex wake is followed in a sequence of streamline visualizations and the wake pattern generated is analyzed. The parameters varied in the visualization experiment are the Reynolds number ranging from 1500 to 10,000, the reduced frequency from 0.1 to 1.0, the mean incidence 30 deg or 15 deg and the angular amplitude 15 deg or 7 deg. There are also two additional parameters of special interest: the airfoil cross section and the pitching axis. The effects of these parameters are discussed in relation to the resultant wake patterns. Some comparison is made with the results of earlier experiments. Author

A91-39744
FLOW AROUND AN UNSTEADY THIN WING CLOSE TO CURVED GROUND
QIAN-XI WANG (University of Science and Technology of China, Hefei, People's Republic of China) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 226, May 1991, p. 175-187. refs
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The method of matched asymptotic expansions is applied to the flow analysis of a three-dimensional thin wing, moving uniformly in very close proximity to a curved ground surface. Four flow regions, i.e., exterior, bow, gap, and wake, are analyzed and matched in an appropriate sequence. The solutions in expansions

up to third order are given both in nonlinear and linear cases. It is shown that the flow above the wing is reduced to a direct problem, and the flow beneath it appears to be a two-dimensional channel flow. The wake assumes a vortex-sheet structure close to the curved ground, undulating with the amplitude of the ground curvature, and the flow beneath it is also two-dimensional channel flow. As a consequence, an equivalence is found between the extreme curved-ground effect and the corresponding flat-ground effect, which can be treated by the image method. Author

A91-39832
STREAM FUNCTIONS FOR THE HYPERSONIC FLOW AROUND QUASI-POINTED SLENDER BODIES AT LOW ANGLES OF ATTACK [FONCTIONS DE COURANT EN ECOULEMENT HYPERSONIQUE AUTOUR D'OGIVES QUASI POINTUES ET A FAIBLE INCIDENCE]
ALAIN MERLEN (ONERA; Lille I, Universite, France) Academie des Sciences, Comptes Rendus, Serie II - Mecanique, Physique, Chimie, Sciences de la Terre et de l'Univers (ISSN 0764-4450), vol. 312, no. 10, May 7, 1991, p. 1065-1070. In English and French. refs
Copyright

The stream functions are calculated analytically for the hypersonic flow around quasi-pointed axisymmetric power-law bodies at small angles of attack. The flow is determined in the framework of the nonsteady flow analogy taking the effect of the free-stream pressure into account as well as that of the quasi-pointed nose, using an entropy correction. Author

A91-39900
AERODYNAMICS AT THE SPEED OF SOUND
R. M. DENNING Aeronautical Journal (ISSN 0001-9240), vol. 95, April 1991, p. 132-137. refs
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The existence of any examples of steady-state conditions in any free-flight or idealized infinite flow fields at Mach 1.0 is challenged. The steady-state theoretical fields often quoted as proof of the existence of such fields are examined, and their intrinsic anomalies and paradoxes are discussed. In view of the perspective thus developed, the accepted interpretation of the nonlinear transonic similarity rule at Mach 1.0 is also challenged. An alternative hypothesis is proposed in which free-flight Mach 1 flow fields must always be unsteady, and cannot be represented in a steady-flow wind tunnel; a method of calculating the forces on a body in such unsteady conditions is presented. O.C.

A91-39911
INVESTIGATIONS ON FLOW INSTABILITIES ON AIRFOILS BY MEANS OF PIEZOFOIL-ARRAYS
W. NITSCHE, P. MIROW, and T. DOERFLER (Berlin, Technische Universitaet, Federal Republic of Germany) IN: Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Toulouse, France, Sept. 11-15, 1989. Berlin and New York, Springer-Verlag, 1990, p. 129-135. Research supported by BMFT and MBB GmbH.
Copyright

Pressure sensitive piezofoil-arrays were applied in order to investigate the dynamic process of transition on airfoils in wind tunnel as well as in flight tests. First emphasis was on a dependable identification of laminar, transitional and turbulent flow regions on the basis of measured wall pressure fluctuations. Apart from this mainly practical application, more detailed analyzing methods were employed in order to examine more closely dynamic processes during transition. This includes, for example, the detection of TS-waves, investigations on the structure of turbulent spots, amplification rates of flow instabilities as well as probability density distributions of wall pressure fluctuations in transitional flows. Author

A91-39919* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TRANSITION RESEARCH IN LOW-DISTURBANCE HIGH-SPEED WIND TUNNELS
I. E. BECKWITH (NASA, Langley Research Center, Hampton, VA), F.-J. CHEN, and M. R. MALIK (High Technology Corp., Hampton, VA) IN: Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Toulouse, France, Sept. 11-15, 1989. Berlin and New York, Springer-Verlag, 1990, p. 227-238. refs
Copyright

The technical requirements and test data from the Mach 3.5 Pilot Low-Disturbance Tunnel are presented. This unique facility provides a test region with essentially zero-acoustic noise and simulates, for the first time, the low-disturbance conditions of atmospheric flight. Applications to the test results of linear stability theory with the e exp N method indicate that transition locations for both simple and complex flows are well predicted by using N of about 9 to 11. Author

A91-39922
ON THE INSTABILITY OF HYPERSONIC FLOW PAST A WEDGE
STEPHEN COWLEY (Imperial College of Science, Technology, and Medicine, London, England) and PHILIP HALL (Exeter, University, England) IN: Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Toulouse, France, Sept. 11-15, 1989. Berlin and New York, Springer-Verlag, 1990, p. 261-270. refs
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The instability of a compressible flow past a wedge is investigated in the hypersonic limit. Particular attention is given to Tollmien-Schlichting waves governed by triple-deck theory though some discussion of inviscid modes is given. It is shown that the attached shock has a significant effect on the growth rates of Tollmien-Schlichting waves. Moreover, the presence of the shock allows for more than one unstable Tollmien-Schlichting wave. The shock is shown to have little effect on inviscid hypersonic modes for both Chapman and Sutherland Law fluids. Author

A91-39927
EXPERIMENTAL AND THEORETICAL ANALYSIS OF NATURAL TRANSITION ON 'INFINITE' SWEPT WING
D. ARNAL, G. CASALIS, and J. C. JUILLEN (ONERA, Centre d'Etudes et de Recherches de Toulouse, France) IN: Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Toulouse, France, Sept. 11-15, 1989. Berlin and New York, Springer-Verlag, 1990, p. 311-325. refs
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The first part of this paper is concerned with a survey of the methods which can be used for predicting transition on swept wings in incompressible flow; simple transition criteria are presented, and possible extensions of the well known e exp n method to three-dimensional situations are discussed. Applications of these various techniques are given in the second part of the paper; comparisons between measured and predicted transition locations indicate that the key problem lies in the evolution of the stability characteristics from the crossflow direction to the streamwise direction. Author

A91-39929 High Technology Corp., Hampton, VA.
CORRELATION OF BOUNDARY LAYER STABILITY ANALYSIS WITH FLIGHT TRANSITION DATA
F. S. COLLIER, JR. (High Technology Corp., Hampton, VA), D. W. BARTLETT, R. D. WAGNER, V. V. TAT (NASA, Langley Research Center, Hampton, VA), and B. T. ANDERSON (NASA, Flight Research Center, Edwards AFB, CA) IN: Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Toulouse, France, Sept. 11-15, 1989. Berlin and New York, Springer-Verlag, 1990, p. 337-346. refs
Copyright

Recently, NASA completed a boundary-layer transition flight test on an F-14 aircraft which has variable-sweep capability. Transition data were acquired for a wide variety of sweep angles, pressure distributions, Mach numbers, and Reynolds numbers. In this paper, the F-14 flight test is briefly described and N-factor correlations with measured transition locations are presented for one of two gloves flown on the F-14 wing in the flight program; a thin foam and fiberglass glove which provided a smooth sailplane

finish on the basic F-14, modified NACA 6-series airfoil. For these correlations, an improved linear boundary-layer stability theory was utilized that accounts for compressibility and surface and streamline curvature effects for the flow past swept wings. Author

A91-39931
CROSS-FLOW INSTABILITY OF 3-D BOUNDARY LAYERS ON A FLAT PLATE
NOBUTAKE ITOH (National Aerospace Laboratory, Chofu, Japan) IN: Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Toulouse, France, Sept. 11-15, 1989. Berlin and New York, Springer-Verlag, 1990, p. 359-368. refs
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The earlier instability of three-dimensional boundary layers on a swept-back wing is primarily due to the existence of cross-flows perpendicular to outer potential flows. When a flat plate is placed in a uniform flow under a pressure gradient in the direction parallel to the leading edge, the boundary layer has a similar cross-flow, even if there is no sweep angle. Linear stability characteristics of such a class of flows are investigated on the basis of the Orr-Sommerfeld equation, and compared with those of the usual three-dimensional boundary layers where the cross-flow is induced by the pressure gradient in the direction normal to the leading edge in cooperation with the sweep angle of a wing. Author

A91-39932* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EXPERIMENTS ON SWEPT-WING BOUNDARY LAYERS
J. R. DAGENHART (NASA, Langley Research Center, Hampton, VA), WILLIAM S. SARIC, JON A. HOOS, and MARC C. MOUSSEUX (Arizona State University, Tempe) IN: Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Toulouse, France, Sept. 11-15, 1989. Berlin and New York, Springer-Verlag, 1990, p. 369-380. refs
(Contract NAG1-937; NAG1-1032)
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Three-dimensional boundary-layer experiments are currently being conducted on a 45-deg swept wing in the Arizona State University Unsteady Wind Tunnel. Crossflow-dominated transition is produced via a model with contoured end liners to simulate infinite swept-wing flow. Fixed-wavelength stationary and traveling crossflow vortices are observed. The stationary vortex wavelengths vary with Reynolds number as predicted by linear-stability theory, but with observed wavelengths which are about 25 percent smaller than theoretically predicted. The frequencies of the most amplified moving waves are in agreement with linear stability theory; however, traveling waves at higher frequencies than predicted are also observed. These higher-frequency waves may be harmonics of the primary crossflow waves generated by a parametric resonance phenomena. Boundary-layer profiles measured at several spanwise locations show streamwise disturbance profiles characteristic of the crossflow instability. Author

A91-39933* Analytical Services and Materials, Inc., Hampton, VA.
ON THE STABILITY OF SWEPT WING LAMINAR BOUNDARY LAYERS INCLUDING CURVATURE EFFECTS
J. VIKEN (Analytical Services and Materials, Inc., Hampton, VA), F. S. COLLIER, JR. (High Technology Corp., Hampton, VA), R. D. WAGNER, and D. W. BARTLETT (NASA, Langley Research Center, Hampton, VA) IN: Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Toulouse, France, Sept. 11-15, 1989. Berlin and New York, Springer-Verlag, 1990, p. 381-388. refs
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A linear stability analysis that encompasses curvature effects has been conducted in wind tunnel experiments on a swept NACA 64(2)-A015 wing, and published transition-onset results have been correlated with computed N-factor values. A strong stabilizing influence is noted upon the growth of the crossflow disturbance, when the flow is accelerated in regions of high body curvature. The maximum amplified crossflow disturbances were in all cases travelling waves; when TS waves reached their maximum, the N-factors at transition lay in the 9.9-13.8 range. Stabilization due to curvature effects was less pronounced in cases where acceleration occurred over a large portion of chord. O.C.

A91-39936* Analytical Services and Materials, Inc., Hampton, VA.
BLUNT-NOSED SWEPT SUPERCRITICAL LFC WINGS WITHOUT NOSE FLAPS
W. PFENNINGER, C. S. VEMURU (Analytical Services and Materials, Inc., Hampton, VA), and F. COLLIER (High Technology Corp., Hampton, VA) IN: Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Toulouse, France, Sept. 11-15, 1989. Berlin and New York, Springer-Verlag, 1990, p. 401-415. refs
(Contract NAS1-18599)
Copyright

To simplify the design of swept supercritical (SC) Laminar Flow Control (LFC) wings and maintain satisfactory low speed characteristics, blunt-nosed swept SC LFC wings without nose flaps and lower wing loadings were studied. Their boundary layer crossflow in the leading edge area is optimally controlled (1) by compensating the boundary layer crossflow of the front acceleration zone by an opposite crossflow in a downstream pressure rise area, (2) by maintaining a neutrally stable boundary layer crossflow by suction within a narrow spanwise suction strip located close to the wing attachment line in the front acceleration zone. The required suction massflow and power are then very small, especially considering the strongly stabilizing effect of surface and streamline curvature on crossflow stability. Author

A91-39937
INSTABILITY FEATURES APPEARING ON SWEPT WING CONFIGURATIONS
H. BIPPES (DLR, Institut fuer experimentelle Stroemungsmechanik, Goettingen, Federal Republic of Germany) IN: Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Toulouse, France, Sept. 11-15, 1989. Berlin and New York, Springer-Verlag, 1990, p. 419-430. refs
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In order to provide a more detailed physical understanding of transition on swept wing configurations, possible instability mechanisms are studied in basic experiments. The models are chosen such that the individual mechanisms can be investigated separately as far as practicable. Most emphasis is placed on the identification of the sources of streamwise vortices which in many experiments on swept wings have been observed as dominant instability. In the stagnation region, streamwise vortices only develop if a spanwise periodicity or a specific type of velocity fluctuations are superimposed upon the oncoming flow. In the unstable three-dimensional boundary layer, however, at turbulence levels less than 0.15 percent, the streamwise vortices have proved to be the most amplified disturbance mode, contrary to the prediction of linear stability theory. In the three-dimensional boundary layer on a concave surface nonstationary waves are found as dominant instability. Author

A91-39938
DEVELOPMENT AND INTERACTION OF INSTABILITIES IN THE CROSSFLOW FIELD
Y. KOHAMA, F. OHTA, and K. SEGAWA (Tohoku University, Sendai, Japan) IN: Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Toulouse, France, Sept. 11-15, 1989. Berlin and New York, Springer-Verlag, 1990, p. 431-440. refs
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Systematic investigation has been performed to make clear the three-dimensional boundary-layer transition mechanism on a swept cylinder which gives fundamenntal transition informations for swept main wing of Airbus-class aircraft. Combined use of hot wire anemometer, smoke and liquid crystal film visualizations made it possible to clarify the quantitative spatial view of the transition process where two instabilities are interacting with each other, and the relation between the velocity field and the heat transfer field. The result shows that the crossflow vortex (stationary primary instability) is important to the turbulent transition process only

secondarily in the sense that they deform the three-dimensional boundary-layer velocity field into inflectional one locally in streamwise direction. This condition directly produces the inflectional instability (traveling secondary instability) which is important primarily to the turbulent transition process. Author

A91-39940* Exeter Univ. (England).
ON THE GOERTLER VORTEX INSTABILITY MECHANISM AT HYPERSONIC SPEEDS
P. HALL and Y. B. FU (Exeter, University, England) IN: Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Toulouse, France, Sept. 11-15, 1989. Berlin and New York, Springer-Verlag, 1990, p. 453-463. refs
(Contract NAS1-18107; AF-AFOSR-89-0042)
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The linear instability of the hypersonic boundary layer on a curved wall is considered. As a starting point real-gas effects are ignored and the viscosity of the fluid is taken to be related to the temperature either by Chapman's Law or by Sutherland's Law. It is shown that the flow is susceptible to Goertler vortices. If Chapman's Law is used the vortices are trapped in the logarithmically thin adjustment layer in which the temperature of the basic flow changes rapidly to its free stream value and the nonuniqueness of the neutral stability curve associated with incompressible Goertler vortices is shown to disappear at high Mach numbers if the appropriate 'fast' streamwise dependence of the instability is built into the disturbance flow structure. If, on the other hand, Sutherland's Law is used, the vortices are found to spread into an O(1) region and the concept of a unique neutral stability curve is not tenable because of the nonparallel effects. For both laws the leading order terms in the expansions of the Goertler number are independent of the wave number and are due to the curvature of the basic state. Author

A91-39941
VISUAL STUDY OF BOUNDARY LAYER TRANSITION ON ROTATING FLAT PLATE
S. MASUDA and M. MATSUBARA (Keio University, Yokohama, Japan) IN: Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Toulouse, France, Sept. 11-15, 1989. Berlin and New York, Springer-Verlag, 1990, p. 465-474. refs
Copyright

The effect of Coriolis acceleration on transition of a rotating Blasius boundary layer has been visually investigated. A flat plate is installed in the small-size wind tunnel rotating around the axis parallel to the leading edge. The air flow is visualized by introducing paraffin mist from a wall slit. The transition of the low pressure side boundary layer was found to be characterized by the turbulent spot, while the pressure-side boundary layer was associated with the longitudinal vortex instability. The variation of the boundary layer parameters as well as the velocity fluctuation signals during transition can be well explained by the present visualization results. Author

A91-39944
THE EXPERIMENTAL INVESTIGATION OF STABILITY AND RECEPTIVITY OF A SWEPT-WING FLOW
IU. S. KACHANOV and O. I. TARARYKIN (AN SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR) IN: Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Toulouse, France, Sept. 11-15, 1989. Berlin and New York, Springer-Verlag, 1990, p. 499-509. refs
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The flow over a swept wing was simulated with the help of a flat-plate flow with a pressure gradient induced by a contoured wall bump. Complete agreement of the experimental data on the structure of both potential flow and boundary layer with calculations for the swept flow was obtained. An artificial generation in the boundary layer of controlled stationary instability waves permits, for the first time, to obtain all the main characteristics of the stability of the swept boundary layer and to carry out the direct comparison of the data obtained with the stability theory under experimental conditions. The receptivity of the swept-wing flow to the surface uneveness of different magnitudes was also studied. Author

A91-39950
THEORETICAL STUDY OF GOERTLER VORTICES - LINEAR STABILITY APPROACH
S. JALLADE, D. ARNAL (ONERA, Centre d'Etudes et de Recherches de Toulouse, France), and H. H. MINH (Ecole Nationale Superieure d'Electrotechnique, d'Electronique, d'Informatique et d'Hydraulique, Toulouse, France) IN: Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Toulouse, France, Sept. 11-15, 1989. Berlin and New York, Springer-Verlag, 1990, p. 565-572. refs
Copyright

Linear stability theory is presently used to calculate the stability of Goertler vortices. Attention is given to the fact that different values of the amplification rate can appear for the same Goertler number. While the application of theory to this problem yields an analytic dispersion relation, it is established that several assumptions of the linear theory are not valid at low wave numbers. Since the nonlinear effects which can affect the development of Goertler vortices are not yet well known, however, an effort has been made to develop a numerical simulation. O.C.

A91-39957* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SECOND MODE INTERACTIONS IN SUPERSONIC BOUNDARY LAYERS
GORDON ERLEBACHER (NASA, Langley Research Center, Hampton, VA) and M. Y. HUSSAINI (NASA, Langley Research Center; ICASE, Hampton, VA) IN: Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Toulouse, France, Sept. 11-15, 1989. Berlin and New York, Springer-Verlag, 1990, p. 631-641. refs
Copyright

The nonlinear evolution of a two-dimensional second mode unstable wave in a Mach 4.5 wall-bounded flow is computed by solving the full time-dependent compressible Navier-Stokes equations. A highly accurate solution is obtained using spectral collocation methods. It is shown that departure from linearity first occurs in the critical layer due to the cubic nonlinearities in the momentum equation. This is a direct result of the large density perturbations in this regime. Time evolution studies of the growth rate as a function of normal distance from the plate suggests that the mode is evolving toward a nonlinear saturated state, and that this problem is possibly amenable to standard weakly nonlinear perturbation methods. Author

A91-39960
BOUNDARY LAYER TRIPPING IN SUPERSONIC FLOW
D. ARNAL, F. VIGNAU, and J. C. JUILLEN (ONERA, Centre d'Etudes et de Recherches de Toulouse, France) IN: Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Toulouse, France, Sept. 11-15, 1989. Berlin and New York, Springer-Verlag, 1990, p. 669-679. refs
Copyright

This experimental study is concerned with the problem of boundary layer tripping by three-dimensional roughness elements in supersonic flow. Two series of experiments are reported: in the first one, the problem of the 'effective roughness height' is examined, and flat plate results are compared with the predictions deduced from the criterion proposed by Van Driest and Blumer. In the second series of measurements, attention is focused on attachment line problems, which are related with the appearance of leading edge contamination on swept models. Author

A91-39964
VISUALISATION OF BOUNDARY LAYER TRANSITION
L. GAUDET (Royal Aerospace Establishment, Bedford, England) IN: Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Toulouse, France, Sept. 11-15, 1989. Berlin and New

York, Springer-Verlag, 1990, p. 699-704.
Copyright

A technique involving the use of liquid crystals which are solely sensitive to shear stress has been employed to visualize the fine detail in the transition process from laminar to turbulent flow in the boundary layer on wind tunnel models of various wing configurations. Examples are given of natural and forced transition in two-dimensional flow at subsonic speeds and the effects of isolated and distributed roughness elements are compared. In regions where the flow is highly three-dimensional, particularly at transonic speeds, the presence of laminar cross flow instabilities is well defined by parallel striations in the surface flow pattern which can lead to the development of tubulence. Author

A91-40126#
SYNCHRONOUS ITERATIVE METHOD FOR COMPUTATION OF VORTEX FLOWS AT HIGH ANGLES OF ATTACK
ZHANG WU (Beijing University, People's Republic of China) and SHIJUN LUO (Northwestern Polytechnical University, Xian, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, Jan. 1991, p. A1-A5. In Chinese, with abstract in English. refs

A robust iterative method suitable for the numerical simulation of vortex flows at high angles of attack is established based upon the multiple line-vortex model. Convergent solutions of vortical flows over bodies of revolution for angles of attack up to 60 deg are obtained. Calculated values of the aerodynamical loads on a tangent-ogive forebody compare well with experimental data. Author

A91-40137#
TRANSONIC ANALYSIS AND DESIGN USING AN IMPROVED GRID
XUESONG BAI and ZIQIANG ZHU (Beijing University of Aeronautics and Astronautics, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, Jan. 1991, p. A75-A79. In Chinese, with abstract in English. refs

CO grid is generated by using an algebraic method. In this grid transonic full potential equation is solved by the finite volume method. The calculated results agree well with experimental data, while the computation time is reduced by a factor of 1/3-1/4 of the one required in CH grid. Transonic analysis and design using this improved grid can be made not only for large aspect ratio wings, but also for small aspect ratio wings without any difficulties. Author

A91-40215*# Old Dominion Univ., Norfolk, VA.
AIRFOIL TRANSITION AND SEPARATION STUDIES USING AN INFRARED IMAGING SYSTEM
EHUD GARTENBERG and A. S. ROBERTS, JR. (Old Dominion University, Norfolk, VA) Journal of Aircraft (ISSN 0021-8669), vol. 28, April 1991, p. 225-230. refs
(Contract NAG1-735)
Copyright

An infrared imaging system was used to detect the thermal signature of boundary-layer flow regimes on a NACA 0012 airfoil from zero angle of attack up to separation. The boundary-layer transition from laminar to turbulent flow and the onset of separation could be seen on the airfoil thermograms. The findings were compared against the behavior of aluminum foil tufts observable both visually and with the infrared imaging system. This arrangement offers the option of using the infrared imaging system both for flow regime detection through surface thermography and flow visualization by the aluminum foil tufts. Ultimately the surface temperature changes due to variation in the angle of attack of a lifting surface provide a means for interpretation of the boundary-layer flow regimes. Author

A91-40216*# Missouri Univ., Rolla.
AERODYNAMIC CHARACTERISTICS OF SCISSOR-WING GEOMETRIES
BRUCE P. SELBERG, KAMRAN ROKHSAZ (Missouri-Rolla, University, Rolla), and CLINTON S. HOUSH Journal of Aircraft (ISSN 0021-8669), vol. 28, April 1991, p. 231-238. refs
(Contract NAG1-975)
Copyright

A scissor-wing configuration, consisting of two independently sweeping-wing surfaces, is compared with an equivalent fixed-wing geometry baseline over a wide Mach number range. The scissor-wing configuration is shown to have a higher total lift-to-drag ratio than the baseline in the subsonic region primarily due to the slightly higher aspect ratio of the unswept scissor wing. In the transonic region, the scissor wing is shown to have a higher lift-to-drag ratio than the baseline for values of lift coefficient greater than 0.35. It is also shown that, through the use of wing decalage, the lift of the two independent scissor wings can be equalized. In the supersonic regime, the zero lift wave drag of the scissor-wing at maximum sweep is shown to be 50 and 28 percent less than the zero lift wave drag of the baseline at Mach numbers 1.5 and 3.0, respectively. In addition, a pivot-wing configuration is introduced and compared with the scissor wing. The pivot-wing configuration is shown to have a slightly higher total lift-to-drag ratio than the scissor wing in the supersonic region due to the decreased zero lift wave drag of the pivot-wing configuration. Author

A91-40217*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EULER ANALYSIS OF A HIGH-SPEED CIVIL TRANSPORT CONCEPT AT MACH 3
JAMES L. PITTMAN, DARYL L. BONHAUS, SAMUEL M. DOLLYHIGH (NASA, Langley Research Center, Hampton, VA), and MICHAEL J. SICLARI (Grumman Aerospace Corp., Bethpage, NY) Journal of Aircraft (ISSN 0021-8669), vol. 28, April 1991, p. 239-245. Previously cited in issue 21, p. 3261, Accession no. A89-49680. refs
Copyright

A91-40218#
CALCULATION OF LOW REYNOLDS NUMBER FLOWS AT HIGH ANGLES OF ATTACK
T. CEBECI, H. H. CHEN (California State University, Long Beach), R. H. LIEBECK (Douglas Aircraft Co., Long Beach, CA), and M. MCILVAINE Journal of Aircraft (ISSN 0021-8669), vol. 28, April 1991, p. 246-252. Previously cited in issue 06, p. 759, Accession no. A90-19921. refs
Copyright

A91-40219*# California Univ., Davis.
AERODYNAMIC CHARACTERISTICS OF CRESCENT AND ELLIPTIC WINGS AT HIGH ANGLES OF ATTACK
C. P. VAN DAM (California, University, Davis), P. M. H. W. VIJGEN (High Technology Corp., Hampton, VA), and B. J. HOLMES (NASA, Langley Research Center, Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 28, April 1991, p. 253-260. Previously cited in issue 08, p. 1102, Accession no. A90-22196. refs
(Contract NAG1-732; NAS1-18240)
Copyright

A91-40220*# Pennsylvania State Univ., University Park.
EXPERIMENTS ON THE UNSTEADINESS ASSOCIATED WITH A GROUND VORTEX
J. M. CIMBALA, M. L. BILLET, D. P. GAUBLOMME, and J. C. OEFELEIN (Pennsylvania State University, University Park) Journal of Aircraft (ISSN 0021-8669), vol. 28, April 1991, p. 261-267. refs
(Contract NAG2-484)
Copyright

The ground vortex formed by a jet impinging on the ground in the presence of a crossflow has been studied experimentally. High speed motion pictures and spectral measurements were obtained to study the unsteady features of this flowfield. A very low-frequency pulsation or 'puffing' instability was observed. Since this unsteadiness could not be correlated with any other oscillations in the flowfield, the low-frequency oscillations must come from the gross features of the ground vortex itself. Namely, jet fluid accumulates in the ground vortex until the vortex is so large that

the flowfield breaks up, the ground vortex is swept away, a new smaller vortex forms, and the process repeats itself. Measurements of the frequency of these oscillations are presented for the first time, and data on the vertical extent (height) of the ground vortex are also shown. Author

A91-40223*# San Diego State Univ., CA.
STATIC MEASUREMENTS OF SLENDER DELTA WING ROLLING MOMENT HYSTERESIS
JOSEPH KATZ (San Diego State Univerity, CA) and DANIEL LEVIN (NASA, Ames Research Center, Moffett Field, CA) Journal of Aircraft (ISSN 0021-8669), vol. 28, April 1991, p. 282, 283. refs (Contract NCC2-596)
Copyright

Slender delta wing planforms are susceptible to self-induced roll oscillations due to aerodynamic hysteresis during the limit cycle roll oscillation. Test results are presented which clearly establish that the static rolling moment hysteresis has a damping character; hysteresis tends to be greater when, due to either wing roll or side slip, the vortex burst moves back and forth over the wing trailing edge. These data are an indirect indication of the damping role of the vortex burst during limit cycle roll oscillations. O.C.

A91-40225#
LOW-ORDER PANEL METHOD FOR INTERNAL FLOWS
K. SUDHAKAR and G. R. SHEVARE (Indian Institute of Technology, Bombay, India) Journal of Aircraft (ISSN 0021-8669), vol. 28, April 1991, p. 286-288. refs
Copyright

A low-order panel method is proposed in order to minimize analysis errors for internal flows through complex three-dimensional ducts, as well as external and internal-external flows, using constant-source and doublet-on-flat-panel approximations of the geometry in question. This formulation is aimed at the a priori reduction of gradients in the unknown doublet distribution. Attention is given to the cases of a duct with lateral offset, a bifurcated duct, and an S-shaped duct. O.C.

A91-40373#
A NEW PSEUDO-POTENTIAL FUNCTION MODEL FOR ROTATIONAL FLOW AND ITS APPLICATION TO TRANSONIC-SUPERSONIC FLOW
GAOLIAN LIU (Shanghai Institute of Mechanical Engineering, People's Republic of China) Journal of Engineering Thermophysics (ISSN 0253-231X), vol. 12, Feb. 1991, p. 20-26. In Chinese, with abstract in English. refs

By means of the term-condensing method, a new general function, the pseudopotential function is introduced, being a simple and consistent generalization of the potential function to general rotational flow. It retains the advantages of the potential function, while removing the restriction of flow potentiality (namely homentropy and homrothalpy). The general formulations of rotational flow along S(1) and S(2) stream sheets in turbomachines are derived, and methods of solution are given with special attention to trans- and supersonic flow, providing a new physically consistent and computationally simple flow-model. Author

A91-40375#
COMPUTATION OF THREE-DIMENSIONAL FLOW FIELDS THROUGH COMPRESSOR BLADE ROWS
WEI NING, XINHAI ZHOU, and YONG LIU (Northwestern Polytechnical University, Xian, People's Republic of China) Journal of Engineering Thermophysics (ISSN 0253-231X), vol. 12, Feb. 1991, p. 42-45. In Chinese, with abstract in English. refs

An Euler solver has been set up for the calculation of the fully three-dimensional inviscid transonic flow in a blade passage of an axial compressor votor or stator. MacCormack's explicit time-marching method is used to solve the unsteady Euler equations on a finite difference mesh. Flows in a set of high-turning cascade and in a transonic compressor rotorblade rows have been analyzed and compared with experimental results; these comparisons have generally shown that this Euler solver is reliable and practicable, and is expected to be used in the practical design computation of transonic compressors and gas turbines. Author

A91-40472#
ANALYSIS OF CIRCULAR ELASTIC MEMBRANE WINGS
TAKESHI SUGIMOTO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 39, no. 447, 1991, p. 180-187. In Japanese, with abstract in English. refs

Membrane wings, such as sails of yachts and hang-gliders, have quite complicated aerodynamic characteristics owing to interactions between compliant wings and the flow around them. All the existing methods of solution for three-dimensional membrane wing theories contain iterative procedures to deal with the strong nonlinearity of the problem. The uniform tension is assumed to weaken this nonlinearity, so that the iterative procedures can be eliminated. This method is aplied to the problem of circular elastic membrane wings. Numerical results have been compared with experimental results. The consistency between the analysis and the experiment shows the validity of the method. The existence of two equilibria is also confirmed. Author

A91-40473#
MODELING FOR UNSTEADY AERODYNAMICS OF RECTANGULAR WING IN INCOMPRESSIBLE FLOW USING STEP RESPONSES
SHINJI SUZUKI and KOSYU KADOTA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 39, no. 447, 1991, p. 188-194. In Japanese, with abstract in English. refs

This paper considers approximating unsteady aerodynamic forces acting on a rectangular wing in the time domain. Time responses of the aerodynamic forces caused by a step movement of a rectangular wing in incompressible flow are calculated by using the time domain vortex element method. Transient characteristics in the step responses can be represented by one decreasing function regardless of wing motions. By approximating the decreasing function with a set of exponential functions and by calculating apparent mass coefficients and steady state forces, a mathematical model for the aerodynamic forces in the form of first-order linear time-invariant differential equations (the state equations) is obtained. The results obtained for the example problems show that a good fit to the aerodynamic forces can be achieved with two exponential functions approximating the decreasing function. Author

A91-40498
ANALYSIS OF NUMERICAL SOLUTIONS FOR THREE-DIMENSIONAL LIFTING WING FLOWS
K. M. WANIE, E. H. HIRSCHEL, and M. A. SCHMATZ (MBB GmbH, Munich, Federal Republic of Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X), vol. 15, no. 2, 1991, p. 107-118. BMFT-supported research. refs
Copyright

Numerical solutions for three-dimensional lifting wing flows are analyzed with regard to their kinematic properties. For this purpose the various levels of modeling real flow and the corresponding governing equations are shortly reviewed. Physical principles and compatibility conditions inherent in these models are discussed. The degree of accordance of the numerical solutions with this physical basis is investigated. Results of this kind of analysis are both a better understanding of physical and numerical properties of the solutions and hints for the development and improvement of numerical solution procedures. Author

A91-40513
FLUID DYNAMICS FOR THE STUDY OF TRANSONIC FLOW
HEINRICH J. RAMM (Tennessee, University, Tullahoma) New York, Oxford University Press, 1990, 209 p. refs
Copyright

The characteristics of transonic flow problems are explored in an introduction for engineering students. The fundamental principles of aerodynamics are reviewed, and particular attention is given to the theory of inviscid transonic flow, nonsteady transonic flow, lift

slope and drag rise at sonic speed, analytical solutions of the transonic continuity equation, viscous transonic flow, numerical methods of transonic flow computation, steps toward the optimal transonic aircraft, and transonic wind-tunnel testing. Diagrams, graphs, photographs, and sample problems are provided. D.G.

A91-40557#
A VORTEX PANEL METHOD FOR CALCULATING AIRCRAFT DOWNWASH ON PARACHUTE TRAJECTORIES
T. L. FULLERTON, J. H. STRICKLAND, and W. D. SUNDBERG (Sandia National Laboratories, Albuquerque, NM) AIAA, Aerodynamic Decelerator Systems Technology Conference, 11th, San Diego, CA, Apr. 9-11, 1991. 9 p.
(Contract DE-AC04-76DP-00789)
(AIAA PAPER 91-0875) Copyright

This paper provides an overview of some recent work done to examine the effects of aircraft wakes on parachute system performance. Summaries of both the model used to predict velocites induced by the aircraft on the parachutes and the model used to predict the resulting parachute trajectories are given. Results show that the impact conditions may be affected significantly under certain conditions. Author

A91-40561*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
HOT GAS INGESTION TEST RESULTS OF A TWO-POSTER VECTORED THRUST CONCEPT WITH FLOW VISUALIZATION IN THE NASA LEWIS 9- BY 15-FOOT LOW SPEED WIND TUNNEL
ALBERT L. JOHNS, GEORGE NEINER, TIMOTHY J. BENCIC (NASA, Lewis Research Center, Cleveland, OH), JOSEPH D. FLOOD, KURT C. AMUEDO (McDonnell Aircraft Co., Saint Louis, MO) et al. AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, 26th, Orlando, FL, July 16-18, 1990. 27 p. Previously announced in STAR as N91-21116.
(AIAA PAPER 90-2268) Copyright

A 9.2 percent scale STOVL hot gas ingestion model was tested in the NASA Lewis 9 x 15-foot Low-Speed Wind Tunnel. Flow visualization from the Phase 1 test program, which evaluated the hot ingestion phenomena and control techniques, is covered. The Phase 2 test program evaluated the hot gas ingestion phenomena at higher temperatures and used a laser sheet to investigate the flow field. Hot gas ingestion levels were measured for the several forward nozzle splay configurations and with flow control/life improvement devices (LIDs) which reduced the hot gas ingestion. The test was conducted at full scale nozzle pressure ratios and inlet Mach numbers. Results are presented over a range of nozzle pressure ratios at a 10 kn headwind velocity. The Phase 2 program was conducted at exhaust nozzle temperatures up to 1460 R and utilized a sheet laser system for flow visualization of the model flow field in and out of ground effects. The results reported are for nozzle exhaust temperatures up to 1160 R and contain the compressor face pressure and temperature distortions, the total pressure recovery, the inlet temperature rise, and the environmental effects of the hot gas. The environmental effects include the ground plane contours, the model airframe heating, and the location of the ground flow separation. Author

A91-40562*# California Univ., Los Angeles.
EULER CALCULATIONS OF UNSTEADY TRANSONIC FLOW IN CASCADES
ODDVAR O. BENDIKSEN (California, University, Los Angeles) AIAA, ASME, ASCE, AHS, and ASC, Structures, Structural Dynamics and Materials Conference, 32nd, Baltimore, MD, Apr. 8-10, 1991. 11 p. NSF-supported research. refs
(Contract NAS3-25574)
(AIAA PAPER 91-1104) Copyright

In the present paper, Euler calculations of unsteady transonic flow in cascades are presented. A finite volume scheme is used to discretize the equations, which are implemented on a blade-fitted deformable mesh. The space-discretized equations are integrated forward in time using a multistage Runge-Kutta scheme. Adaptive dissipation terms of the type proposed by Jameson and Baker are added to capture shocks and to suppress nonphysical oscillations. Phase-shifted boundary conditions are used to reduce the computational domain to a single reference passage. No assumptions of small amplitudes or small flow deflections are made. Thus, the present code makes it possible to carry out aeroelastic calculations for cases where the shock strengths and oscillation amplitudes exceed the inherent limitations of potential flow codes. Author

N91-23078# Old Dominion Univ., Norfolk, VA.
AN EXPERIMENTAL STUDY OF AN AXISYMMETRIC TURBULENT BOUNDARY LAYER DISTURBED BY A PERIODIC FREESTREAM Ph.D. Thesis
CHITHRABHANU KOODALATTUPURAM Apr. 1990 212 p
Avail: NTIS HC/MF A10

Behavior of an axisymmetric equilibrium turbulent boundary layer disturbed by a propeller wake in the freestream was investigated experimentally. Tests were conducted in a low speed wind tunnel and measurements of turbulence quantities were made using an x wire probe and a constant temperature anemometer. The boundary layer flow on a cylindrical body was characterized by measuring its gross parameters and comparing them with classical values. Propeller speed was measured using an electronic circuit whose output signal was also used to trigger the hot wire probe. Gross boundary layer characteristics of the disturbed boundary layer did not deviate appreciably from the classical two dimensional turbulent boundary layer except immediately behind the propeller. From conditional sampling, it was found that the near wall periodic Reynolds stress approached 30 percent of the conventional time averaged Reynolds stress. Turbulent kinetic energy, kinetic energy of the organized field, and various kinetic energy production terms responsible for exchange of turbulent kinetic energy between different flow fields were calculated from the experimental data. It was found that kinetic energy was being transferred from the organized flow field to the random turbulent flow field, as expected. The variation of both periodic and turbulent kinetic energy were governed by similar equations. A mechanism for the transport of turbulent kinetic energy was suggested. Dissert. Abstr.

N91-23079# Federal Aviation Administration, Cambridge, MA.
AIRCRAFT WAKE VORTICES: AN ASSESSMENT OF THE CURRENT SITUATION Final Report, Mar. - Aug. 1990
J. N. HALLOCK Jan. 1991 67 p
(AD-A231658; DOT-VNTSC-FAA-90-6; DOT/FAA/RD-90/29)
Avail: NTIS HC/MF A04 CSCL 01/1

The state of knowledge about aircraft wake vortices in the summer of 1990 is summarized. With the advent of a new FAA wake vortex program, the current situation was assessed by answering five questions: (1) what is known about wake vortices, (2) what isn't known about wake vortices, (3) what are the requirements and limitations for operational systems to solve the wake vortex problems, (4) where does one go from here, and (5) why is there a need to collect more wake vortex data. GRA

N91-23080*# Rockwell International Corp., Los Angeles, CA.
AERODYNAMIC PRELIMINARY ANALYSIS SYSTEM 2. PART 1: THEORY
E. BONNER, W. CLEVER, and K. DUNN Apr. 1991 144 p
(Contract NAS1-18015)
(NASA-CR-182076; NAS 1.26:182076) Avail: NTIS HC/MF A07 CSCL 01/1

An aerodynamic analysis system based on potential theory at subsonic and/or supersonic speeds and impact type finite element solutions at hypersonic conditions is described. Three dimensional configurations having multiple nonplanar surfaces of arbitrary planform and bodies of noncircular contour may be analyzed. Static, rotary, and control longitudinal and lateral directional characteristics may be generated. The analysis was implemented on a time sharing system in conjunction with an input tablet digitizer and an interactive graphics input/output display and editing terminal to maximize its responsiveness to the preliminary analysis problem. The program

provides an efficient analysis for systematically performing various aerodynamic configuration tradeoff and evaluation studies.
Author

N91-23081*# Rockwell International Corp., Los Angeles, CA.
AERODYNAMIC PRELIMINARY ANALYSIS SYSTEM 2. PART 2: USER'S MANUAL
G. SOVA, P. DIVAN, and L. SPACHT Apr. 1991 339 p
(Contract NAS1-18015)
(NASA-CR-182077; NAS 1.26:182077) Avail: NTIS HC/MF A15 CSCL 01/1

An aerodynamic analysis system based on potential theory at subsonic and/or supersonic speeds and impact type finite element solutions at hypersonic conditions is described. Three dimensional configurations have multiple nonplanar surfaces of arbitrary planforms and bodies of noncircular contour may be analyzed. Static, rotary, and control longitudinal and lateral-directional characteristics may be generated. The analysis was implemented on a time sharing system in conjunction with an input tablet digitizer and an interactive graphics input/output display and editing terminal to maximize its responsiveness to the preliminary analysis. Computation times on an IBM 3081 are typically less than one minute of CPU/Mach number at subsonic, supersonic, or hypersonic speeds. This is a user manual for the computer programming. Author

N91-23082 California Univ., Berkeley.
INTERFEROMETRIC INVESTIGATION OF SUPERSONIC FLOW FIELDS WITH SHOCK-SHOCK INTERACTIONS Ph.D. Thesis
MARK PAUL LOOMIS 1990 127 p
Avail: Univ. Microfilms Order No. DA9103798

An experimental investigation of the two-dimensional interaction between an oblique shock wave generated by a wedge and the bow shock upstream of an cylinder placed in cross flow is presented. New interferometric techniques to provide density information on the entire flow field were compared to previous investigations. Results were compared with a concurrent numerical investigation. The data obtained are useful in documenting and understanding such complex flow fields as that occurring when oblique shocks impinge on the cowl inlet of a vehicle such as the National Aerospace Plane. Depending on the position of the impinging shock with respect to the bow shock, type 1, 2, and 3 interactions as defined by Edney were obtained. The experiments were performed in a 14 by 14 cm supersonic wind tunnel with a nominal Mach number of 2.4. The primary experimental emphasis was the development of interferometric techniques and the application of these techniques to provide interferometric data for the different types of interactions. Since the flow field was two dimensional, the global density was deduced from the interferograms. Two types of interferometers were constructed and used, holographic interferometry and dark central ground interferometry. Using holographic interferometry, interferograms were made by storing holographically two images of the test section, one at test conditions and one with no flow in the tunnel. By comparing the two images an interferogram was constructed after the test had taken place. The second interferometer used a relatively new technique called dark central ground interferometry. The method involved placing a spatial filter at the focal point of the system after the beam has passed through the test section. Since the technique produces real time interferograms it was found to have many advantages over holographic interferometry. The current study represents one of the first applications of this technique in routine wind tunnel testing. Dissert. Abstr.

N91-23083*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NASA AEROPROPULSION RESEARCH IN SUPPORT OF PROPULSION SYSTEMS OF THE 21ST CENTURY
JOSEPH A. ZIEMIANSKI and EDWARD A. WILLIS (Sverdrup Technology, Inc., Brook Park, OH.) 1991 26 p Presented at the 36th International Gas Turbine and Aeroengine Congress and Exposition, Orlando, FL, 3-6 Jun. 1991; sponsored by ASME
(NASA-TM-104403; E-6226; NAS 1.15:104403) Avail: NTIS HC/MF A03 CSCL 01/1

A review is given of the NASA's ongoing and planned research and technology programs leading to advanced air breathing propulsion systems of the next century. The primary focus is on efforts being performed or sponsored by NASA-Lewis, with emphasis on civil, subsonic, and supersonic transportation systems which should begin to enter service within 10 to 20 years. Subsonic transport propulsion program elements, including ducted UltraHigh Bypass (UHB) engines and high efficiency cores are discussed in terms of goals, technical issues and problems, approaches and plans. Similarly, The Supersonic Cruise Propulsion Program is reviewed via discussion of near term and far term goals; barrier issues such as NOx and noise reduction and the consequent Phase 1 (near term) research plans are described; and finally, emerging technologies such as the supersonic through-flow fan are considered for their potential long term impact. Author

N91-23084*# Minnesota Univ., Minneapolis. Dept. of Aerospace Engineering and Mechanics.
A STUDY OF THE NOISE MECHANISMS OF TRANSONIC BLADE-VORTEX INTERACTIONS Semiannual Technical Report
ANASTASIOS S. LYRINTZIS and Y. XUE 1990 37 p Presented at the AHS 46th Annual Forum, Washington, DC, 21-23 May 1990
(Contract NAG2-588; NAG2-646)
(NASA-CR-188199; NAS 1.26:188199) Avail: NTIS HC/MF A03 CSCL 01/1

Transonic blade-vortex interactions (BVI) are simulated numerically and the noise mechanisms are investigated. The two-dimensional high frequency transonic small disturbance equation is solved numerically (VTRAN2 code). An ADI scheme with monotone switches is used; viscous effects are included on the boundary, and the vortex is simulated by the cloud in cell method. The Kirchhoff method is used for the extension of the numerical two-dimensional near-field aerodynamic results to the linear acoustic three dimensional far field. The viscous effects (shock/boundary layer interactions) on BVI is investigated. The different types of shock motion are identified and compared. Two important disturbances with different directivity exist in the pressure signal and are believed to be related to the fluctuating lift and drag forces. Noise directivity for different cases is shown. The maximum radiation occurs at an angle between 60 and 90 degrees below the horizontal for an airfoil-fixed coordinate system and depends on the details of the airfoil shape. Different airfoil shapes are studied and classified according to the BVI noise produced.
Author

N91-23085# Sandia National Labs., Albuquerque, NM.
A VORTEX PANEL METHOD FOR CALCULATING AIRCRAFT DOWNWASH ON PARACHUTE TRAJECTORIES
T. L. FULLERTON, J. H. STRICKLAND, and W. D. SUNDBERG 1991 8 p Presented at the 11th AIAA Aerodynamic Decelerator Systems Technology Conference, San Diego, 9-11 Apr. 1991
(Contract DE-AC04-76DP-00789)
(DE91-009764; SAND-90-2178C; CONF-9104171-7) Avail: NTIS HC/MF A02

A discussion is presented of a methodology of the paneled wing method for calculating aircraft induced wake velocities. This discussion includes a description of how an aircraft and its wake are represented by finite length vortex filaments, how the strength and location of these filaments are determined based upon aircraft characteristics and trajectory data, and how the induced velocity values are determined once the location and strength of the vortex filaments are known. Examples are presented showing comparisons between induced velocity values calculated using both the paneled wing method and Strickland's lifting line method. Comparison is also made between calculated results from the paneled wing method and wind tunnel data collected in the wake of a scale model aircraft. Additional examples show the effect of including aircraft downwash calculations in a trajectory analysis for a parachute-retarded store delivered via aircraft. DOE

N91-23086*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SIMULATION OF ICED WING AERODYNAMICS
M. G. POTAPCZUK, M. B. BRAGG, O. J. KWON, and L. N. SANKAR (Georgia Inst. of Tech., Atlanta.) 1991 17 p Presented at the 68th Fluid Dynamics Panel Specialists Meeting, Toulouse, France, 29 Apr. - 1 May 1991; sponsored by AGARD
(NASA-TM-104362; E-6158; NAS 1.15:104362) Avail: NTIS HC/MF A03 CSCL 01/1

The sectional and total aerodynamic load characteristics of moderate aspect ratio wings with and without simulated glaze leading edge ice were studied both computationally, using a three dimensional, compressible Navier-Stokes solver, and experimentally. The wing has an untwisted, untapered planform shape with NACA 0012 airfoil section. The wing has an unswept and swept configuration with aspect ratios of 4.06 and 5.0. Comparisons of computed surface pressures and sectional loads with experimental data for identical configurations are given. The abrupt decrease in stall angle of attack for the wing, as a result of the leading edge ice formation, was demonstrated numerically and experimentally. Author

N91-23087*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ICING SIMULATION: A SURVEY OF COMPUTER MODELS AND EXPERIMENTAL FACILITIES
M. G. POTAPCZUK and J. J. REINMANN 1991 29 p Presented at the 68th Fluid Dynamics Panel Specialists Meeting, Toulouse, France, 29 Apr. - 1 May 1991; sponsored by AGARD
(NASA-TM-104366; E-6164; NAS 1.15:104366) Avail: NTIS HC/MF A03 CSCL 01/1

A survey of the current methods for simulation of the response of an aircraft or aircraft subsystem to an icing encounter is presented. The topics discussed include a computer code modeling of aircraft icing and performance degradation, an evaluation of experimental facility simulation capabilities, and ice protection system evaluation tests in simulated icing conditions. Current research focussed on upgrading simulation fidelity of both experimental and computational methods is discussed. The need for increased understanding of the physical processes governing ice accretion, ice shedding, and iced airfoil aerodynamics is examined. Author

N91-23088# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen (Germany, F.R.). Hauptabt. Windkanaele.
PROCEDURE FOR DETERMINATION OF THREE-DIMENSIONAL WIND TUNNEL WALL INTERFERENCES AND WALL ADAPTATION IN COMPRESSIBLE SUBSONIC FLOW USING MEASURED WALL PRESSURES Thesis - Technische Univ.
HARMUT HOLST 11 Dec. 1990 171 p In GERMAN; ENGLISH summary
(DLR-FB-90-46; ISSN-0171-1342; ETN-91-99067) Avail: NTIS HC/MF A08; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 60 DM

Green's Theorem is applied to the problem of wall interferences in wind tunnels. The velocity components at the boundaries of the test section are the data required for the calculation. The computation of the wall adaptation is performed in a single step. Measurements in an adaptive test section show that the method can be used for the determination of wall interferences, wall adaptation, and residual interferences. Computations demonstrate that optimization of slot widths in test sections with longitudinally slotted walls and calculation of residual interferences can be performed using this method. The limitations of the method are discussed. ESA

N91-23089*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A STUDY OF THREE DIMENSIONAL TURBULENT BOUNDARY LAYER SEPARATION AND VORTEX FLOW CONTROL USING THE REDUCED NAVIER STOKES EQUATIONS
BERNHARD H. ANDERSON and SAEED FAROKHI (Kansas Univ., Lawrence.) 1991 8 p Presented at the Turbulent Shear Flow Symposium, Munich, Fed. Republic of Germany, 9-11 Sep. 1991
(NASA-TM-104407; E-6233; NAS 1.15:104407) Avail: NTIS HC/MF A02 CSCL 01/1

A reduced Navier Stokes (RNS) initial value space marching solution technique was applied to vortex generator and separated flow problems and demonstrated good predictions of the engine face flow field. This RNS solution technique using FLARE approximations can adequately describe the topological and topographical structure flow separation associated with vortex liftoff, and this conclusion led to the concept of a subclass of separations which can be called vorticity separations: separations dominated by the transport of vorticity. Adequate near wall resolution of vorticity separations appears necessary for good predictions of these flows. Author

N91-23092# Cranfield Inst. of Tech., Bedford (England). Dept. of Aerodynamics.
THE PERFORMANCE OF 60 DEG DELTA WINGS: THE EFFECTS OF LEADING EDGE RADIUS ON VORTEX FLAPS AND THE WING
B. K. HU and J. L. STOLLERY Mar. 1990 35 p
(CRANFIELD-AERO-9004; ISBN-1-871564-05-0; ETN-91-99333) Avail: NTIS HC/MF A03

Low speed wind tunnel tests were conducted on 60 degree delta wings. The wings were tested with well rounded and sharp leading edge vortex flaps to estimate the effects of leading edge radius on the aerodynamic performance. The Reynolds number based on root chord was approx. 800,000. Results indicate that leading edge radius has little effect on the contribution of the vortex flap to lift/drag ratio on the 60 deg delta wing. The 60 deg delta wing with a well rounded leading edge and no vortex flap deflection has a higher lift/drag ratio over almost the entire lift coefficient range tested. ESA

N91-23094# Lehigh Univ., Bethlehem, PA.
UNSTEADY FLOW STRUCTURE FROM SWEPT EDGES SUBJECTED TO CONTROLLED MOTION Final Report, 1 May 1986 - 31 Oct. 1990
DONALD ROCKWELL 26 Dec. 1990 89 p
(Contract AF-AFOSR-0177-86; AF PROJ. 2307)
(AD-A232714; LU-AFOSR-FR-90; AFOSR-91-0139TR) Avail: NTIS HC/MF A05 CSCL 01/1

This program addresses the unsteady flow structure and loading of delta wings subjected to controlled pitching motion. Efforts are focussed on three primary areas: generation of computer-aided techniques for quantitative interpretation of flow structure; development of new types of experimental instrumental and facilities; and characterization of the unsteady flow structure on delta wings. Computer applications for quantitative visualization of the vortex structure involve tracking of hydrogen bubble timelines and particles illuminated by scanning lasers. These techniques are integrated with active control systems that generate prescribed pitching motion of delta wings. Characterization of the unsteady flow structure is concerned with the response of the vortex breakdown to the motion of the wing and with preliminary consideration of the instantaneous cross-sectional structure of the leading edge vortices. The phase lag of these features of the flow structure, relative to the wing motion, is a central consideration. GRA

N91-23161# Cranfield Inst. of Tech., Bedford (England). Coll. of Aeronautics.
SOME ASPECTS OF SHOCK-WAVE BOUNDARY LAYER INTERACTION RELEVANT TO INTAKE FLOWS
J. L. STOLLERY *In* AGARD, Hypersonic Combined Cycle Propulsion 14 p Dec. 1990
Copyright Avail: NTIS HC/MF A20; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Four main topics are discussed: (1) 2-D shock induced separation; (2) 3-D glancing interaction; (3) shock/shock boundary layer interaction; and (4) hypersonic viscous interaction. Wherever

possible both laminar and turbulent flows are considered and reference is made to experimental data and to the results of mathematical modeling. Some thoughts on future research topics are presented along with the facilities needed to pursue them. Author

N91-23164# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.). Inst. fuer Antriebstechnik.
AERODYNAMICS AND STABILIZATION OF COMBUSTION OF HYDROGEN JETS INJECTED INTO SUBSONIC AIRFLOW
J. KOOPMAN, M. RACHNER, H. WIEGAND, and H. EICKHOFF *In* AGARD, Hypersonic Combined Cycle Propulsion 16 p Dec. 1990
Copyright Avail: NTIS HC/MF A20; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The aerodynamics and stabilization of burning hydrogen jets, injected transversally into a subsonic airstream, were investigated. The structural behavior of deflecting cold and burning jets were studied by flow visualization. Experiments and numerical analysis on jet penetration were performed. Flame extinction limits of 'wake stabilized' flames were established and correlated. Author

N91-23174# Rome Univ. (Italy). Dipt. di Meccanica e Aeronautica.
REACTING SHOCK WAVES IN HYPERSONIC PROPULSION APPLICATIONS
M. ONOFRI *In* AGARD, Hypersonic Combined Cycle Propulsion 10 p Dec. 1990
Copyright Avail: NTIS HC/MF A20; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Problems connected to the occurrence of finite rate chemical processes behind shock waves in hypersonic flow fields are analyzed and a numerical technique is proposed for their solution. The computational difficulties connected with the presence of large gradients of the species concentrations are considered. A method is proposed, based on a shock-fitting technique for the gas dynamic model and a variable step integration along the streamlines for the energy and species conservation equations. This approach provides the needed resolution where it is actually required, without becoming cumbersome elsewhere, and the relaxation layer behind shocks can be computed efficiently and precisely. Author

N91-23175*# Sverdrup Technology, Inc., Cleveland, OH.
VISCOUS THREE-DIMENSIONAL ANALYSES FOR NOZZLES FOR HYPERSONIC PROPULSION
G. J. HARLOFF, D. R. REDDY, and H. T. LAI *In* AGARD, Hypersonic Combined Cycle Propulsion 18 p Dec. 1990
Previously announced as N90-17635
Copyright Avail: NTIS HC/MF A20; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive
CSCL 01/1

A Navier-Stokes computer code was validated using a number of two- and three-dimensional configurations for both laminar and turbulent flows. The validation data covers a range of freestream Mach numbers from 3 to 14, including wall pressures, velocity pressure, and skin friction. Nozzle flow fields computed for a generic scramjet nozzle from Mach 3 to 20, wall pressures, wall skin friction values, heat transfer values, and overall performance are presented. In addition, three-dimensional solutions obtained for two asymmetric, single expansion ramp nozzles at a pressure ratio of 10 consists of the internal expansion region in the converging/diverging sections and the external superonic exhaust in a quiescent ambient environment. The fundamental characteristics that were captured successfully include expansion fans; Mach wave reflections; mixing layers; and nonsymmetrical, multiple inviscid cell, supersonic exhausts. Comparison with experimental data for wall pressure distributions at the center planes shows good agreement. Author

N91-24098*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THE NASA LANGLEY LAMINAR-FLOW-CONTROL EXPERIMENT ON A SWEPT, SUPERCRITICAL AIRFOIL: SUCTION COEFFICIENT ANALYSIS
CUYLER W. BROOKS, JR., CHARLES D. HARRIS, and WILLIAM D. HARVEY Jun. 1991 19 p
(NASA-TM-4267; L-16774; NAS 1.15:4267) Avail: NTIS HC/MF A03 CSCL 01/1

A swept supercritical wing incorporating laminar flow control at transonic flow conditions was designed and tested. The definition of an experimental suction coefficient and a derivation of the compressible and incompressible formulas for the computation of the coefficient from measurable quantities is presented. The suction flow coefficient in the highest velocity nozzles is shown to be overpredicted by as much as 12 percent through the use of an incompressible formula. However, the overprediction on the computed value of suction drag when some of the suction nozzles were operating in the compressible flow regime is evaluated and found to be at most 6 percent at design conditions. Author

N91-24099*# Texas A&M Univ., College Station. Dept. of Aerospace Engineering.
AN INITIAL INVESTIGATION INTO METHODS OF COMPUTING TRANSONIC AERODYNAMIC SENSITIVITY COEFFICIENTS Semiannual Progress Report, Jul. - Dec. 1990
LELAND A. CARLSON Feb. 1991 108 p
(Contract NAG1-793)
(NASA-CR-188192; NAS 1.26:188192; TAMRF-5802-91-01)
Avail: NTIS HC/MF A06 CSCL 01/1

The three dimensional quasi-analytical sensitivity analysis and the ancillary driver programs are developed needed to carry out the studies and perform comparisons. The code is essentially contained in one unified package which includes the following: (1) a three dimensional transonic wing analysis program (ZEBRA); (2) a quasi-analytical portion which determines the matrix elements in the quasi-analytical equations; (3) a method for computing the sensitivity coefficients from the resulting quasi-analytical equations; (4) a package to determine for comparison purposes sensitivity coefficients via the finite difference approach; and (5) a graphics package. Author

N91-24103 Georgia Inst. of Tech., Atlanta.
AERODYNAMIC INTERACTIONS BETWEEN BODIES IN RELATIVE MOTION Ph.D. Thesis
OLIVIER SCHREIBER 1990 281 p
Avail: Univ. Microfilms Order No. DA9105464

The problem of aerodynamic interactions between bodies in arbitrary relative motion is considered, with emphasis on the aerodynamics of rotor with fuselage interactions. This problem is too complex to be analyzed using the full Navier-Stokes equations, and it has previously been shown that the dominant features of such flow field can be explained using ideal fluid flow concepts. Thus, an ideal fluid flow formulation, allowing complex unsteady interactions between arbitrary shaped bodies, is used. The computational scheme is time dependent and designed to handle several bodies moving with respect to each other, such as a rotor and fuselage. It is not specialized in its treatment of lifting versus nonlifting bodies or their motion characteristics. The wakes of the bodies are modeled by vortex particle. The handling of the Helmholtz equation, which governs vorticity convection and distortion and its interaction with the bodies, is simplified. Stability and convergence of the scheme are made by smearing the discrete point distribution over finite elementary volumes and using a multistep time marching integration method. A mix of boundary element methods is used simultaneously to solve the boundary value problem. Dissert. Abstr.

N91-24104 Georgia Inst. of Tech., Atlanta.
AN EFFICIENT HYBRID SCHEME FOR THE SOLUTION OF ROTATIONAL FLOW AROUND ADVANCED PROPELLERS Ph.D. Thesis

RAKESH SRIVASTAVA 1990 154 p
Avail: Univ. Microfilms Order No. DA9105466

A free air propeller offers the highest propulsive efficiency. However, as the flight speed increases, the high tip speed of a conventional propeller leads to large compressibility losses. To overcome these losses and extend the flight Mach number to near transonic range, propellers were redesigned to have large tip sweep, twist, and very thin airfoils. The efficiency was further increased by using a counter-rotating row of blades to recover the swirl losses. One problem with these advanced propellers, however, is that some of the propellers have fluttered in wind tunnel tests. In order to be able to predict flutter, an accurate prediction of unsteady airloads is necessary. Also, as the propellers operate in the transonic Mach number range, compressibility effects become important. In the present solution procedure, three-dimensional, unsteady, compressible Euler equations are solved. A directionally hybrid scheme is used to make the scheme computationally more efficient. The governing equations are cast in strong conservative form and solved in a body-fitted coordinate system using an approximate factorization scheme. Specifically, the solution procedure is applied to solve Euler equations around single and counter-rotating advanced propeller geometries to obtain airloads and integrated performance quantities. The solution procedure was also coupled with NASTRAN in an open loop fashion, to study the effects of blade flexibility on the performance of the single rotation advanced propeller. An attempt was also made to evaluate the possibility of reducing the number of grid points in the solution domain by using a fourth-order scheme.
Author

N91-24105*# Stanford Univ., CA. Dept. of Aeronautics and Astronautics.
NONLINEAR AERODYNAMICS AND THE DESIGN OF WING TIPS Final Report, 1 Apr. 1990 - 31 Mar. 1991
ILAN KROO May 1991 5 p
(Contract NCC2-683)
(NASA-CR-188044; NAS 1.26:188044) Avail: NTIS HC/MF A01 CSCL 01/1

The analysis and design of wing tips for fixed wing and rotary wing aircraft still remains part art, part science. Although the design of airfoil sections and basic planform geometry is well developed, the tip regions require more detailed consideration. This is important because of the strong impact of wing tip flow on wing drag; although the tip region constitutes a small portion of the wing, its effect on the drag can be significant. The induced drag of a wing is, for a given lift and speed, inversely proportional to the square of the wing span. Concepts are proposed as a means of reducing drag. Modern computational methods provide a tool for studying these issues in greater detail. The purpose of the current research program is to improve the understanding of the fundamental issues involved in the design of wing tips and to develop the range of computational and experimental tools needed for further study of these ideas.

N91-24106*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE COMPUTATION OF INDUCED DRAG WITH NONPLANAR AND DEFORMED WAKES
ILAN KROO (Stanford Univ., CA.) and STEPHEN SMITH *In* Stanford Univ., Nonlinear Aerodynamics and the Design of Wing Tips 9 p May 1991
Avail: NTIS HC/MF A01 CSCL 01/1

The classical calculation of inviscid drag, based on far field flow properties, is reexamined with particular attention to the nonlinear effects of wake roll-up. Based on a detailed look at nonlinear, inviscid flow theory, it is concluded that many of the classical, linear results are more general than might have been expected. Departures from the linear theory are identified and design implications are discussed. Results include the following: Wake deformation has little effect on the induced drag of a single element wing, but introduces first order corrections to the induced drag of a multi-element lifting system. Far field Trefftz-plane analysis may be used to estimate the induced drag of lifting systems, even when wake roll-up is considered, but numerical difficulties arise. The implications of several other approximations made in lifting line theory are evaluated by comparison with more refined analyses.
Author

N91-24107*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
EULER FLOW PREDICTIONS FOR AN OSCILLATING CASCADE USING A HIGH RESOLUTION WAVE-SPLIT SCHEME
DENNIS L. HUFF, TIMOTHY W. SWAFFORD, and T. S. R. REDDY (Toledo Univ., OH.) 1991 19 p Presented at the 36th International Gas Turbine and Aeroengine Congress and Exposition, Orlando, FL, 3-6 Jun. 1991; sponsored by ASME
(NASA-TM-104377; E-5933; NAS 1.15:104377) Avail: NTIS HC/MF A03 CSCL 01/1

A compressible flow code that can predict the nonlinear unsteady aerodynamics associated with transonic flows over oscillating cascades is developed and validated. The code solves the two dimensional, unsteady Euler equations using a time-marching, flux-difference splitting scheme. The unsteady pressures and forces can be determined for arbitrary input motions, although only harmonic pitching and plunging motions are addressed. The code solves the flow equations on a H-grid which is allowed to deform with the airfoil motion. Predictions are presented for both flat plate cascades and loaded airfoil cascades. Results are compared to flat plate theory and experimental data. Predictions are also presented for several oscillating cascades with strong normal shocks where the pitching amplitudes, cascade geometry and interblade phase angles are varied to investigate nonlinear behavior.
Author

N91-24108*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SUCKDOWN, FOUNTAIN LIFT, AND PRESSURES INDUCED ON SEVERAL TANDEM JET V/STOL CONFIGURATIONS
DAVID C. BELLAVIA, DOUGLAS A. WARDWELL, VICTOR R. CORSIGLIA, and RICHARD E. KUHN (STO-VL Technology, San Diego, CA.) Mar. 1991 154 p
(NASA-TM-102817; A-90144; NAS 1.15:102817) Avail: NTIS HC/MF A08 CSCL 01/1

As part of a program to improve the methods for predicting the suckdown and hot gas ingestion for jet V/STOL aircraft in ground effect, a data base is being created that provides a systematic variation of parameters so that a new empirical prediction procedure can be developed. The first series of tests in this program was completed. Suckdown, fountain lift, and pressures induced on several two-jet V/STOL configurations are described. It is one of three reports that present the data obtained from tests conducted at Lockheed Aeronautical Systems-Rye Canyon Facility and in the High Bay area of the 40 by 80 foot wind tunnel complex at NASA Ames Research Center.
Author

N91-24109*# Notre Dame Univ., IN. Dept. of Aerospace and Mechanical Engineering.
BREAKING DOWN THE DELTA WING VORTEX: THE ROLE OF VORTICITY IN THE BREAKDOWN PROCESS Ph.D. Thesis Final Report
ROBERT C. NELSON and KENNETH D. VISSER 1990 16 p Presented at AGARD Symposium on Vortex Flow Aerodynamics, Scheveningen, Netherlands, 1-4 Oct. 1990
(Contract NAG1-1156)
(NASA-CR-188235; NAS 1.26:188235) Avail: NTIS HC/MF A03 CSCL 01/1

Experimental x-wire measurements of the flowfield above a 70 and 75 deg flat plate delta wing were performed at a Reynolds number of 250,000. Grids were taken normal to the wing at various chordwise locations for angles of attack of 20 and 30 deg. Axial and azimuthal vorticity distributions were derived from the velocity fields. The dependence of circulation on distance from the vortex core and on chordwise location was also examined. The effects of nondimensionalization in comparison with other experimental data is made. The results indicate that the circulation distribution

scales with the local semispan and grows in a nearly linear fashion in the chordwise direction. The spanwise distribution of axial vorticity is severely altered through the breakdown. The axial vorticity components with a negative sense, such as that found in the secondary vortex, seem to remain unaffected by changes in wind sweep or angle of attack, in direct contrast to the positive components. In addition, the inclusion of the local wing geometry into a previously derived correlation parameter allows the circulation of growing leading edge vortex flows to be reduced into a single curve. Author

N91-24110*# Notre Dame Univ., IN. Dept. of Aerospace and Mechanical Engineering.
AN EXPERIMENTAL ANALYSIS OF CRITICAL FACTORS INVOLVED IN THE BREAKDOWN PROCESS OF LEADING EDGE VORTEX FLOWS Ph.D. Thesis
KENNETH D. VISSER 30 May 1991 285 p
(Contract NAG1-1156)
(NASA-CR-188231; NAS 1.26:188231) Avail: NTIS HC/MF A13 CSCL 01/1

Experimental crosswire measurements of the flowfield above a 70 and 75 degree flat plate delta wing were performed at a Reynolds number of 250,000. Survey grids were taken normal to the platform at a series of chordwise locations for angles of attack of 20 and 30 degrees. Axial and azimuthal vorticity distributions were derived from the velocity fields. The dependence of circulation on distance from the vortex core as well as on chordwise location was examined. The effects of nondimensionalization in comparison with other experimental data was made. The circulation distribution scales with the local semispan and grows approximately linearly in the chordwise direction. For regions of the flow outside of the vortex subcore, the circulation at any chordwise station was observed to vary logarithmically with distance from the vortex axis. The circulation was also found to increase linearly with angle of incidence at a given chordwise station. A reduction in the local circulation about the vortex axis occurred at breakdown. The spanwise distribution of axial vorticity was severely altered through the breakdown region and the spanwise distribution of axial vorticity present appeared to reach a maximum immediately preceding breakdown. The local concentration of axial vorticity about the vortex axis was reduced while the magnitude of the azimuthal vorticity decreased throughout the breakdown zone. The axial vorticity components with a negative sense, found in the secondary vortex, remained unaffected by changes in wing sweep or angle of attack, in direct contrast to the positive components. The inclusion of the local wing geometry into a previously derived correlation parameter indicated that the circulation of growing leading edge vortex flows were similar at corresponding radii from the vortex axis. It was concluded that the flow over a delta wing, upstream of the breakdown regions and away from the apex and trailing edge regions, is conical. In addition, the dominating factors leading to the onset of breakdown are felt to be the local circulation of the vortex and the accompanying pressure field. Author

N91-24111# Department of Transportation, Cambridge, MA. National Transportation Systems Center.
AIRCRAFT WAKE VORTICES: AN ANNOTATED BIBLIOGRAPHY (1923-1990) Final Report, Jul. - Oct. 1990
J. N. HALLOCK Jan. 1991 392 p
(AD-A233161; DOT-VNTSC-FAA-90-7; DOT/FAA/RD-90-30)
Avail: NTIS HC/MF A17 CSCL 01/1

This annotated bibliography consists of abstracts of publications of aircraft wake vortices. The material is arranged alphabetically by author(s) and then by month and year of publication. Experimental and theoretical articles are included and consider the formation, structure, motion, and decay of vortices and their effect on penetrating aircraft. GRA

N91-24112# Micro Craft, Inc., Tullahoma, TN.
UNSTEADY NAVIER-STOKES SOLUTIONS FOR A LOW ASPECT RATIO DELTA WING Final Report, 1 Sep. 1989 - 1 Sep. 1990
RAYMOND E. GORDNIER Dec. 1990 33 p
(Contract F33601-89-C-0045)
(AD-A233201; WRDC-TR-90-3075) Avail: NTIS HC/MF A03 CSCL 01/1

A numerical investigation of the flow field about a 76-degree leading edge sweep delta wing at 20.5 degree angle of attack is presented. The computational results are obtained using a Beam-Warming algorithm with a Newton-like subiteration procedure. For M = 0.2 and Re = 900,000 an unsteady flow field is obtained which is shown to be physical in nature. The unsteady behavior is a result of the existence of small-scale vortical structures that are associated with a Kelvin-Helmholtz type instability of the shear layer emanating form the leading edge of the delta wing. The computed results show qualitative agreement with other experimental and numerical findings. GRA

N91-24113# Vigyan Research Associates, Inc., Hampton, VA.
CALCULATION OF HIGH ANGLE OF ATTACK AERODYNAMICS OF FIGHTER CONFIGURATIONS. VOLUME 1: STEADY Final Report, Aug. 1987 - Jan. 1990
C. E. LAN, H. EMDAD, SUEI CHIN, P. SUNDARAM, and S. C. MEHROTRA Apr. 1991 82 p
(Contract F33615-87-C-3616)
(AD-A233482; WL-TR-91-3033-VOL-1) Avail: NTIS HC/MF A05 CSCL 01/1

A computational method for lateral-directional aerodynamics of fighter configuration is developed. The leading edge vortices are represented by free vortex filaments which are adjusted iteratively to satisfy the force-free condition. The forebody vortex separation, both symmetrical and asymmetrical, is calculated using slender body theory. Effect of boundary layer separation on lifting surfaces is accounted for using the effective sectional angles of attack. The latter are obtained iteratively by matching the nonlinear sectional lift with the computed resulted based on lifting surface theory. Results for several fighter configurations are employed for comparison with available data. It is shown that the present method produces reasonable results in predicting sideslip derivatives, while role and yaw rate derivatives do not compare very well with forced oscillation test data at high angles of attack. Industrial usage of this has produced mixed results. At this time, the use of these methods in a production manner is not recommended. GRA

N91-24114# Vigyan Research Associates, Inc., Hampton, VA.
CALCULATION OF HIGH ANGLE OF ATTACK AERODYNAMICS OF FIGHTER CONFIGURATIONS. VOLUME 2: USER MANUAL FOR VORSTAB-2 Final Report, Aug. 1987 - Jan. 1990
C. E. LAN, H. EMDAD, SUEI CHIN, P. SUNDARAM, and S. C. MEHROTRA Apr. 1991 173 p
(Contract F33615-87-C-3616)
(AD-A233483; WL-TR-91-3033-VOL-2) Avail: NTIS HC/MF A08 CSCL 01/1

A computational method for lateral-directional aerodynamics of fighter configurations is developed. The leading-edge vortices are represented by free vortex filaments which are adjusted iteratively to satisfy the force-free condition. The forebody vortex separation, both symmetrical and asymmetrical, is calculated using slender body theory. The effect of boundary layer separation on lifting surfaces is accounted for using the effective sectional angles of attack. The latter are obtained iteratively by matching the nonlinear sectional lift with the computed results based on lifting-surface theory. Results for several fighter configurations are employed for comparison with available data. It is shown that the present method produces reasonable results in predicting sideslip derivatives, while roll- and yaw-rate derivatives do not compare very well with forced oscillation test data at high angles of attack. Industrial usage of this has produced mixed results. At this time, the use of these methods in a production manner is not recommended. GRA

N91-24115# Vigyan Research Associates, Inc., Hampton, VA.
CALCULATION OF HIGH ANGLE OF ATTACK AERODYNAMICS OF FIGHTER CONFIGURATIONS. VOLUME 3: UNSTEADY Final Report, Aug. 1987 - Jan. 1990

C. E. LAN, H. EMDAD, SUEI CHIN, P. SUNDARAM, and S. C. MEHROTRA Apr. 1991 59 p
(Contract F33615-87-C-3616)
(AD-A233569; WL-TR-91-3033-VOL-3) Avail: NTIS HC/MF A04 CSCL 01/1

A computational method for unsteady aerodynamics of fighter configurations at high angles of attack is developed. The leading-edge vortices are represented by free vortex filaments which are adjusted iteratively to satisfy the force-free condition. The small-disturbance, unsteady potential equation is solved in the frequency domain for motions in pitching, plunging, flapping, side movement, rolling, and yawing oscillation in compressible flow. Computed results in rolling moment coefficients due to side acceleration are compared with data for 60-deg and 80-deg delta wings. Lateral-directional characteristics for an F-106b configuration are also compared with data obtained in forced oscillation tests. It is shown that reasonable results can be obtained by the present unsteady flow method, but not by steady flow theory. Calculation of dynamic stall effects on a rectangular wing of aspect ratio 4 is demonstrated by using experimental section data. Although no data for the wing are available, the results appear plausible. Industrial usage of this has produced mixed results. At this time, the use of these methods in a production manner is recommended. GRA

N91-24116# Dayton Univ., OH. Dept. of Chemistry.
HYPERSONIC AERODYNAMICS FELLOWSHIPS Final Report, 15 Mar. 1986 - 15 Sep. 1989
JOHN D. ANDERSON, JR. 11 Feb. 1991 40 p
(Contract DAAL03-86-G-0040)
(AD-A233584; ARO-23758.2-EG-F) Avail: NTIS HC/MF A03 CSCL 20/4

This work resulted in: (1) a new approach to hypersonic waverider vehicles, which has lead to a family of waverider with exceptionally promising characteristics, and (2) the first data on the interaction of a vortex with a shock wave at hypersonic speeds. GRA

N91-24118*# Boeing Commercial Airplane Co., Seattle, WA.
DEVELOPING AND UTILIZING AN EULER COMPUTATIONAL METHOD FOR PREDICTING THE AIRFRAME/PROPULSION EFFECTS FOR AN AFT-MOUNTED TURBOPROP TRANSPORT. VOLUME 1: THEORY DOCUMENT Final Report
H. C. CHEN and N. Y. YU Mar. 1991 53 p
(Contract NAS1-18703)
(NASA-CR-181924-VOL-1; NAS 1.26:181924-VOL-1) Avail: NTIS HC/MF A04 CSCL 01/1

An Euler flow solver was developed for predicting the airframe/propulsion integration effects for an aft-mounted turboprop transport. This solver employs a highly efficient multigrid scheme, with a successive mesh-refinement procedure to accelerate the convergence of the solution. A new dissipation model was also implemented to render solutions that are grid insensitive. The propeller power effects are simulated by the actuator disk concept. An embedded flow solution method was developed for predicting the detailed flow characteristics in the local vicinity of an aft-mounted propfan engine in the presence of a flow field induced by a complete aircraft. Results from test case analysis are presented. A user's guide for execution of computer programs, including format of various input files, sample job decks, and sample input files, is provided in an accompanying volume. Author

N91-24119*# Boeing Commercial Airplane Co., Seattle, WA.
DEVELOPING AND UTILIZING AN EULER COMPUTATIONAL METHOD FOR PREDICTING THE AIRFRAME/PROPULSION EFFECTS FOR AN AFT-MOUNTED TURBOPROP TRANSPORT. VOLUME 2: USER GUIDE Final Report
H. C. CHEN, H. E. NEBACK, T. J. KAO, N. Y. YU, and K. KUSUNOSE Mar. 1991 71 p
(Contract NAS1-18703)
(NASA-CR-181924-VOL-2; NAS 1.26:181924-VOL-2) Avail: NTIS HC/MF A04 CSCL 01/1

This manual explains how to use an Euler based computational method for predicting the airframe/propulsion integration effects for an aft-mounted turboprop transport. The propeller power effects are simulated by the actuator disk concept. This method consists of global flow field analysis and the embedded flow solution for predicting the detailed flow characteristics in the local vicinity of an aft-mounted propfan engine. The computational procedure includes the use of several computer programs performing four main functions: grid generation, Euler solution, grid embedding, and streamline tracing. This user's guide provides information for these programs, including input data preparations with sample input decks, output descriptions, and sample Unix scripts for program execution in the UNICOS environment. Author

N91-24120*# Boeing Commercial Airplane Co., Seattle, WA.
A GENERAL MULTIBLOCK EULER CODE FOR PROPULSION INTEGRATION. VOLUME 1: THEORY DOCUMENT Final Report
H. C. CHEN, T. Y. SU, and T. J. KAO May 1991 47 p
(Contract NAS1-18703)
(NASA-CR-187484-VOL-1; NAS 1.26:187484-VOL-1) Avail: NTIS HC/MF A03 CSCL 01/1

A general multiblock Euler solver was developed for the analysis of flow fields over geometrically complex configurations either in free air or in a wind tunnel. In this approach, the external space around a complex configuration was divided into a number of topologically simple blocks, so that surface-fitted grids and an efficient flow solution algorithm could be easily applied in each block. The computational grid in each block is generated using a combination of algebraic and elliptic methods. A grid generation/flow solver interface program was developed to facilitate the establishment of block-to-block relations and the boundary conditions for each block. The flow solver utilizes a finite volume formulation and an explicit time stepping scheme to solve the Euler equations. A multiblock version of the multigrid method was developed to accelerate the convergence of the calculations. The generality of the method was demonstrated through the analysis of two complex configurations at various flow conditions. Results were compared to available test data. Two accompanying volumes, user manuals for the preparation of multi-block grids (vol. 2) and for the Euler flow solver (vol. 3), provide information on input data format and program execution. Author

N91-24121*# Boeing Commercial Airplane Co., Seattle, WA.
A GENERAL MULTIBLOCK EULER CODE FOR PROPULSION INTEGRATION. VOLUME 2: USER GUIDE FOR BCON, PRE-PROCESSOR FOR GRID GENERATION AND GMBE Final Report
T. Y. SU, R. A. APPLEBY, and H. C. CHEN May 1991 71 p
(Contract NAS1-18703)
(NASA-CR-187484-VOL-2; NAS 1.26:187484-VOL-2) Avail: NTIS HC/MF A04 CSCL 01/1

The BCON is a menu-driven graphics interface program whose input consists of strings or arrays of points generated from a computer aided design (CAD) tool or any other surface geometry source. The user needs to design the block topology and prepare the surface geometry definition and surface grids separately. The BCON generates input files that contain the block definitions and the block relationships required for generating a multiblock volume grid with the EAGLE grid generation package. The BCON also generates the block boundary conditions file which is used along with the block relationship file as input for the general multiblock Euler (GMBE) code (GMBE, volumes 1 and 3). Author

N91-24122*# Boeing Commercial Airplane Co., Seattle, WA.
A GENERAL MULTIBLOCK EULER CODE FOR PROPULSION INTEGRATION. VOLUME 3: USER GUIDE FOR THE EULER CODE Final Report
H. C. CHEN, T. Y. SU, and T. J. KAO May 1991 46 p
(Contract NAS1-18703)
(NASA-CR-187484-VOL-3; NAS 1.26:187484-VOL-3) Avail: NTIS HC/MF A03 CSCL 01/1

This manual explains the procedures for using the general multiblock Euler (GMBE) code developed under NASA contract

NAS1-18703. The code was developed for the aerodynamic analysis of geometrically complex configurations in either free air or wind tunnel environments (vol. 1). The complete flow field is divided into a number of topologically simple blocks within each of which surface fitted grids and efficient flow solution algorithms can easily be constructed. The multiblock field grid is generated with the BCON procedure described in volume 2. The GMBE utilizes a finite volume formulation with an explicit time stepping scheme to solve the Euler equations. A multiblock version of the multigrid method was developed to accelerate the convergence of the calculations. This user guide provides information on the GMBE code, including input data preparations with sample input files and a sample Unix script for program execution in the UNICOS environment. Author

N91-24123*# North Carolina State Univ., Raleigh. Dept. of Mechanical and Aerospace Engineering.
THEORETICAL EVALUATION OF ENGINE AUXILIARY INLET DESIGN FOR SUPERSONIC V/STOL AIRCRAFT Final Report
MICHAEL A. BOLES and RICHARD L. HEAVNER Cleveland, OH NASA May 1991 97 p
(Contract NAG3-608)
(NASA-CR-187098; NAS 1.26:187098) Avail: NTIS HC/MF A05 CSCL 01/1

A higher order panel method is used to evaluate the potential flow of a 2-D supersonic V/STOL inlet. A nonsymmetric analytical inlet model is developed to closely match a wind tunnel model tested at NASA-Lewis. The analytical inlet used is analyzed for flow characteristics around the lower cowl lip and auxiliary inlets. The results for this analysis are obtained for the output of a computer program produced by the McDonnell Douglas Corp. This program is based on the Hess Panel Method which determines source strengths of panel distributed over a 3-D body. The analytical model was designed for the implementation of a drooped/translated cowl lip and auxiliary inlets as flow improvement concepts. A 40 or 70 deg droop lip can be incorporated on the inlet to determine if these geometry changes result in flow improvements which may reduce the propensity for flow separation on the interior portion of the lip. Auxiliary inlets are used to decrease the mass flow over the inlet lip; thus, the peak flow velocity is reduced at the lip which also lessens the likelihood of flow separation on the interior portion of the lip. A 2, 4, and 6 in. translated lip can be used to also decrease mass flow over the inlet lower lip in the same manner. Author

N91-24125*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
IMPLICIT SOLVERS FOR UNSTRUCTURED MESHES Final Report
V. VENKATAKRISHNAN (Computer Sciences Corp., Moffett Field, CA.) and DIMITRI J. MAVRIPLIS May 1991 24 p
(Contract NAS1-18605)
(NASA-CR-187564; NAS 1.26:187564; ICASE-91-40) Avail: NTIS HC/MF A03 CSCL 01/1

Implicit methods were developed and tested for unstructured mesh computations. The approximate system which arises from the Newton linearization of the nonlinear evolution operator is solved by using the preconditioned GMRES (Generalized Minimum Residual) technique. Three different preconditioners were studied, namely, the incomplete LU factorization (ILU), block diagonal factorization, and the symmetric successive over relaxation (SSOR). The preconditioners were optimized to have good vectorization properties. SSOR and ILU were also studied as iterative schemes. The various methods are compared over a wide range of problems. Ordering of the unknowns, which affects the convergence of these sparse matrix iterative methods, is also studied. Results are presented for inviscid and turbulent viscous calculations on single and multielement airfoil configurations using globally and adaptively generated meshes. Author

N91-24128*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
FLOW VISUALIZATION STUDY OF A 1/48-SCALE AFTI/F111 MODEL TO INVESTIGATE HORIZONTAL TAIL FLOW DISTURBANCES
LISA J. BJARKE Jun. 1991 35 p Original contains color illustrations
(NASA-TM-101698; H-1547; NAS 1.15:101698) Avail: NTIS HC/MF A03; 24 functional color pages CSCL 01/1

During flight testing of the AFTI/F111 aircraft, horizontal tail buffet was observed. Flutter analysis ruled out any aeroelastic instability, so a water-tunnel flow visualization study was conducted to investigate possible flow disturbances on the horizontal tail which might cause buffet. For this study, a 1/48-scale model was used. Four different wing cambers and one horizontal tail setting were tested between 0 and 20 deg angle of attack. These wing cambers corresponded to the following leading training edge deflections: 0/2, 10/10, 10/2, and 0/10. Flow visualization results in the form of still photographs are presented for each of the four wing cambers between 8 and 12 deg angle of attack. In general, the horizontal tail experiences flow disturbances which become more pronounced with angle of attack or wing trailing-edge deflection. Author

N91-24130*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THE 3-D NAVIER-STOKES ANALYSIS OF CROSSING, GLANCING SHOCKS/TURBULENT BOUNDARY LAYER INTERACTIONS
D. R. REDDY 1991 14 p Presented at the 22nd Fluid Dynamics, Plasma Dynamics and Lasers Conference, Honolulu, HI, 24-26 Jun. 1991; sponsored by AIAA
(NASA-TM-104469; E-6318; NAS 1.15:104469; AIAA-91-1758)
Avail: NTIS HC/MF A03 CSCL 01/1

Three dimensional viscous flow analysis is performed for a configuration where two crossing and glancing shocks interact with a turbulent boundary layer. A time marching 3-D full Navier-Stokes code, called PARC3D, is used to compute the flow field, and the solution is compared to the experimental data obtained at the NASA Lewis Research Center's 1 x 1 ft supersonic wind tunnel facility. The study is carried out as part of the continuing code assessment program in support of the generic hypersonic research at NASA Lewis. Detailed comparisons of static pressure fields and oil flow patterns are made with the corresponding solution on the wall containing the shock/boundary layer interaction in an effort to validate the code for hypersonic inlet applications. Author

N91-24131*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A DESIGN STRATEGY FOR THE USE OF VORTEX GENERATORS TO MANAGE INLET-ENGINE DISTORTION USING COMPUTATIONAL FLUID DYNAMICS
BERNHARD H. ANDERSON and RALPH LEVY (Scientific Research Associates, Inc., Glastonbury, CT.) 1991 36 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; sponsored by AIAA, SAE, ASME, and the American Society for Electrical Engineers
(NASA-TM-104436; E-6275; NAS 1.15:104436; AIAA-91-2474)
Avail: NTIS HC/MF A03 CSCL 01/1

A reduced Navier-Stokes solution technique was successfully used to design vortex generator installations for the purpose of minimizing engine face distortion by restructuring the development of secondary flow that is induced in typical 3-D curved inlet ducts. The results indicate that there exists an optimum axial location for this installation of corotating vortex generators, and within this configuration, there exists a maximum spacing between generator blades above which the engine face distortion increases rapidly. Installed vortex generator performance, as measured by engine face circumferential distortion descriptors, is sensitive to Reynolds number and thereby the generator scale, i.e., the ratio of generator blade height to local boundary layer thickness. Installations of corotating vortex generators work well in terms of minimizing engine face distortion within a limited range of generator scales. Hence,

the design of vortex generator installations is a point design, and all other conditions are off design. In general, the loss levels associated with a properly designed vortex generator installation are very small; thus, they represent a very good method to manage engine face distortion. This study also showed that the vortex strength, generator scale, and secondary flow field structure have a complicated and interrelated influence over engine face distortion, over and above the influence of the initial arrangement of generators. Author

N91-24132*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TRANSONIC SYMPOSIUM: THEORY, APPLICATION AND EXPERIMENT, VOLUME 2
JEROME T. FOUGHNER, JR., comp. Apr. 1989 241 p Symposium held in Hampton, VA, 19-21 Apr. 1988
(NASA-CP-3020-VOL-2; L-16502-VOL-2; NAS 1.55:3020-VOL-2)
Avail: NTIS HC/MF A11 CSCL 01/1

Papers presented at the Transonic Symposium are compiled. The following subject areas are covered: National Transonic Facility status; transonic aerodynamics of slender wing-body configuration; laminar flow flight experiments; laminar flow wind tunnel experiments; computational support of X-29A flight experiment; transition location on a clean-up glove installed on a F-14 aircraft; and design studies for a laminar glove for the X-29 aircraft.

N91-24134*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
REYNOLDS NUMBER EFFECTS ON THE TRANSONIC AERODYNAMICS OF A SLENDER WING-BODY CONFIGURATION
JAMES M. LUCKRING, CHARLES H. FOX, JR., and JEFFREY S. CUNDIFF (George Washington Univ., Hampton, VA.) *In its* Transonic Symposium: Theory, Application and Experiment, Volume 2 p 41-58 Apr. 1989
Avail: NTIS HC/MF A11 CSCL 01/1

Aerodynamic forces and moments for a slender wing-body configuration are summarized from an investigation in the Langley National Transonic Facility (NTF). The results include both longitudinal and lateral-directional aerodynamic properties as well as slideslip derivatives. Results were selected to emphasize Reynolds number effects at a transonic speed although some lower speed results are also presented for context. The data indicate nominal Reynolds number effects on the longitudinal aerodynamic coefficients and more pronounced effects for the lateral-directional aerodynamic coefficients. The Reynolds number sensitivities for the lateral-directional coefficients were limited to high angles of attack. Author

N91-24135*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LAMINAR-FLOW FLIGHT EXPERIMENTS
RICHARD D. WAGNER, DAL V. MADDALON, D. W. BARTLETT, F. S. COLLIER, JR., and A. L. BRASLOW (Analytical Services and Materials, Inc., Hampton, VA.) *In its* Transonic Symposium: Theory, Application and Experiment, Volume 2 p 59-104 Apr. 1989
Avail: NTIS HC/MF A11 CSCL 01/1

The flight testing conducted over the past 10 years in the NASA laminar-flow control (LFC) will be reviewed. The LFC program was directed towards the most challenging technology application, the high supersonic speed transport. To place these recent experiences in perspective, earlier important flight tests will first be reviewed to recall the lessons learned at that time. Author

N91-24136*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LAMINAR-FLOW WIND TUNNEL EXPERIMENTS
WILLIAM D. HARVEY, CHARLES D. HARRIS, WILLIAM G. SEWALL, and JOHN P. STACK *In its* Transonic Symposium: Theory, Application and Experiment, Volume 2 p 105-145 Apr. 1989
Avail: NTIS HC/MF A11 CSCL 01/1

Although most of the laminar flow airfoils recently developed at the NASA Langley Research Center were intended for general aviation applications, low-drag airfoils were designed for transonic speeds and wind tunnel performance tested. The objective was to extend the technology of laminar flow to higher Mach and Reynolds numbers and to swept leading edge wings representative of transport aircraft to achieve lower drag and significantly improved operation costs. This research involves stabilizing the laminar boundary layer through geometric shaping (Natural Laminar Flow, NLF) and active control involving the removal of a portion of the laminar boundary layer (Laminar-Flow Control, LFC), either through discrete slots or perforated surface. Results show that extensive regions of laminar flow with large reductions in skin friction drag can be maintained through the application of passive NLF boundary-layer control technologies to unswept transonic wings. At even greater extent of laminar flow and reduction in the total drag level can be obtained on a swept supercritical airfoil with active boundary layer-control. Author

N91-24139*# Boeing Commercial Airplane Co., Seattle, WA.
VARIABLE SWEEP TRANSITION FLIGHT EXPERIMENT (VSTFE): UNIFIED STABILITY SYSTEM (USS). DESCRIPTION AND USERS' MANUAL Report, Oct. 1985 - May 1990
RODGER A. ROZENDAAL and ROXANNA BEHBEHANI Jun. 1990 124 p
(Contract NAS1-15325)
(NASA-CR-181918; NAS 1.26:181918; D6-54961) Avail: NTIS HC/MF A06 CSCL 01/1

NASA initiated the Variable Sweep Transition Flight Experiment (VSTFE) to establish a boundary layer transition database for laminar flow wing design. For this experiment, full-span upper surface gloves were fitted to a variable sweep F-14 aircraft. The development of an improved laminar boundary layer stability analysis system called the Unified Stability System (USS) is documented and results of its use on the VSTFE flight data are shown. The USS consists of eight computer codes. The theoretical background of the system is described, as is the input, output, and usage hints. The USS is capable of analyzing boundary layer stability over a wide range of disturbance frequencies and orientations, making it possible to use different philosophies in calculating the growth of disturbances on sweptwings. Author

03

AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

A91-38527
AIR TRAVEL - SYSTEM RELATING FLIGHT SAFETY, AIRCRAFT, AND AIRPORTS [DIE LUFTFAHRT - SYSTEM ZWISCHEN FLUGSICHERUNG, FLUGZEUG UND FLUGHAFEN]
JUERGEN LANG and HUBERT FLECKENSTEIN (MBB GmbH/Deutsche Aerospace AG, Munich, Federal Republic of Germany) Ortung und Navigation (ISSN 0474-7550), no. 1, 1991, p. 91-105. In German. refs
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Measures for coping with the ever growing traffic density involved in air travel are discussed. The interaction of aircraft and airport in enhancing air traffic safety is emphasized. Simulation tests of various safety-promoting systems are reviewed. C.D.

A91-38543*# Wichita State Univ., KS.
WATER DROPLET IMPINGEMENT ON AIRFOILS AND AIRCRAFT ENGINE INLETS FOR ICING ANALYSIS
MICHAEL PAPADAKIS (Wichita State University, KS), R. ELANGOVAN, GEORGE A. FREUND, JR., and MARLIN D, BREER (Boeing Military Airplanes, Wichita, KS) Journal of Aircraft (ISSN 0021-8669), vol. 28, March 1991, p. 165-174. FAA-supported

research. refs
(Contract NAG3-566)
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This paper includes the results of a significant research program for verification of computer trajectory codes used in aircraft icing analysis. Experimental water droplet impingement data have been obtained in the NASA Lewis Research Center Icing Research Tunnel for a wide range of aircraft geometries and test conditions. The body whose impingement characteristics are required is covered at strategic locations by thin strips of moisture absorbing (blotter) paper and then exposed to an airstream containing a dyed-water spray cloud. Water droplet impingement data are extracted from the dyed blotter strips by measuring the optical reflectance of the dye deposit on the strips with an automated reflectometer. Impingement characteristics for all test geometries have also been calculated using two recently developed trajectory computer codes. Good agreement is obtained with experimental data. The experimental and analytical data show that maximum impingement efficiency and impingement limits increase with mean volumetric diameter for all geometries tested. For all inlet geometries tested, as the inlet mass flow is reduced, the maximum impingement efficiency is reduced and the location of the maximum impingement shifts toward the inlet inner cowl. Author

A91-39384
AN UPDATE ON SKAD (SURVIVAL KIT AIR DROPPABLE) SYSTEMS
P. D. JOHNSON (Irvin Industries Canada, Ltd., Fort Erie) IN: Annual SAFE Symposium, 27th, New Orleans, LA, Dec. 5-8, 1989, Proceedings. Newhall, CA, SAFE Association, 1990, p. 89-95.
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The status of current SKAD systems, their requirements, and potential future applications are discussed. Tables show sea SKAD test data in terms of 170 KIAS and SKAD survival kit contents, and diagrams illustrate the sea SKAD sequence of operation, the SKAD cross-section, the SKAD container, and container stresses. P.D.

A91-39393
RECENT ESCAPE SYSTEM PARACHUTE EFFORTS AT DOUGLAS AIRCRAFT COMPANY
ROBERT B. CALKINS (McDonnell Douglas Corp., Long Beach, CA) IN: Annual SAFE Symposium, 27th, New Orleans, LA, Dec. 5-8, 1989, Proceedings. Newhall, CA, SAFE Association, 1990, p. 176-180.
Copyright

Recent recovery-parachute development and feasibility programs are described. The programs include the development of the MINNIPAC II recovery-parachute system and the feasibility of a twin-chute personnel-recovery system. The MINIPAC II was found to provide a rapid and reliable pilot-chute deployment upon seat separation, and no hesitations occurred in pilot-chute opening because the chute is deployed outside of the pilot's wake. Studies showed, that with the novel twin-chute system, injuries could be reduced to 2 percent. The design and development of a solid-state data recorder to acquire parachute drop-test data are also discussed. Photographs are provided of the MINIPAC II seat pan with parachute and survival pouches, a packed 26-foot conical in a deployment bag, a bag with three-ring riser releases, a jumper during deployment (with the pilot chute in the low-speed mode), and a dummy in free-fall at 25,000 ft, (with the pilot chute in the high-speed mode). P.D.

A91-40558#
LOW ALTITUDE HIGH SPEED CARGO PARACHUTE SYSTEM DEVELOPMENT - A STATUS REPORT
W. D. SUNDBERG, THOMAS H. ALSBROOKS, KENNETH L. RONQUILLO (Sandia National Laboratories, Albuquerque, NM), JAMES E. SADECK, and CALVIN K. LEE (U.S. Army, Research, Development, and Engineering Center, Natick, MA) AIAA, Aerodynamic Decelerator Systems Technology Conference, 11th, San Diego, CA, Apr. 9-11, 1991. 16 p. refs
(AIAA PAPER 91-0880) Copyright

A Low Altitude High Speed Cargo (LAHSC) parachute is being developed for deployment at velocities up to 250 knots at 300 ft altitude. The LAHSC parachute will decelerate and turnover a load to a 40 to 60 ft/sec vertical velocity at first vertical at approximately 30 ft AGL. The acceleration limit is 5 g's. Main chute cargo extraction will be necessary. A single parachute will be utilized for a 7500 lb load, and clusters will be used for larger loads. The 64-gore, 70-ft-dia parachute has a ring-slot/solid construction with a flare at the skirt to aid the inflation. This paper describes the parachute, the design process and testing to date. Model parachutes have been tested in wind tunnels and in free flight. A single full-scale parachute has been tested at low speeds with conventional load extraction, and with a vertical trajectory at deployment. Author

A91-40559#
DEPLOYMENT OPTIMIZATION AND HUMAN FACTORS CONSIDERATIONS FOR LOW-ALTITUDE TROOP PARACHUTES
JOHN W. WATKINS (U.S. Army, Research, Development, and Engineering Center, Natick, MA) AIAA, Aerodynamic Decelerator Systems Technology Conference, 11th, San Diego, CA, Apr. 9-11, 1991. 14 p.
(AIAA PAPER 91-0889)

On of the major objectives in the development of troop parachutes is to reduce the jump altitude. This requires faster parachute deployment, inflation, and stabilization. At this time, it has not been possible to make significant reductions in jump altitude through improvements in deployment and stabilization. Faster inflation and a corresponding reduction in altitude loss was achieved through the development of special reefing techniques, but testing showed that opening forces could exceed human factors limits. An investigation was done to verify and more closely define the presently accepted human factors limits. These limits have remained the same. The results from tests of a wide variety of parachutes were then compiled to determine the potential for meeting the jump altitude requirement without exceeding the human factors limits. This investigation showed that while it would be possible, careful optimization of the reefing technique used to speed up inflation is required. Author

N91-23095*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
AIRBORNE RESCUE SYSTEM Patent Application
LEONARD A. HASLIM, inventor (to NASA) 6 Oct. 1989 17 p
(NASA-CASE-ARC-11909-1; NAS 1.71:ARC-11909-1; US-PATENT-APPL-SN-418320) Avail: NTIS HC/MF A03 CSCL 01/3

The airborne rescue system includes a boom with telescoping members for extending a line and collar to a rescue victim. The boom extends beyond the tip of the helicopter rotor so that the victim may avoid the rotor downwash. The rescue line is played out and reeled in by winch. The line is temporarily retained under the boom. When the boom is extended, the rescue line passes through clips. When the victim dons the collar and the tension in the line reaches a predetermined level, the clips open and release the line from the boom. Then the rescue line can form a straight line between the victim and the winch, and the victim can be lifted to the helicopter. A translator is utilized to push out or pull in the telescoping members. The translator comprises a tape and a rope. Inside the telescoping members the tape is curled around the rope and the tape has a tube-like configuration. The tape and rope are provided from supply spools. NASA

N91-23096 California Univ., Berkeley.
NEAR MIDAIR COLLISIONS AS AN INDICATOR OF GENERAL AVIATION COLLISION RISK Ph.D. Thesis
H. PAUL SHUCH 1990 225 p
Avail: Univ. Microfilms Order No. DA9103873

Conventional wisdom suggests aircraft midair collisions to be random events, governed by the laws of Brownian Motion, and best analyzed by stochastic methods. An alternative hypothesis, that such accidents are deterministic in nature, and that specific

factors leading to midair collisions can be identified and mitigated, is discussed. A predictive model using case control theory is developed for assessing Risk Index, a criterion measure of midair collision likelihood, for any General Aviation flight, actual or hypothetical. Generating the model requires statistical validation of two independent near midair collision data bases, and identifying within them those aircraft, aircrew and airspace characteristics most closely associated with collision risk. Dissert. Abstr.

N91-23097# Boeing Commercial Airplane Co., Seattle, WA. Advanced Programs-Payloads.
AIRCRAFT COMMAND IN EMERGENCY SITUATIONS (ACES). PHASE 1: CONCEPT DEVELOPMENT Final Report
THOMAS L. REYNOLDS, GREGORY E. GRIMSTAD, and CHARLES D. ANDERSON Apr. 1991 136 p
(Contract DTFA03-89-C-00061)
(DOT/FAA/CT-90/21) Avail: NTIS HC/MF A07

Two conceptual approaches for an advanced smoke/fire detection system for commercial passenger jet aircraft are defined that would provide for accurate, timely guidance to the flight crew for their use in responding to possible and/or actual inflight smoke and fire events within the pressurized fuselage. The motivation for this was the computerization of the modern commercial jet aircraft flight deck, the evolution toward the two-man crew, and documented times taken to locate and implement the appropriate emergency procedure. The primary objective of the Aircraft Command in Emergency Situations (ACES) System concepts are to provide the capability to reduce the time required for the flight deck crew to make a decision to land the aircraft. Author

N91-23098*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ENGINE TECHNOLOGY CHALLENGES FOR A 21ST CENTURY HIGH SPEED CIVIL TRANSPORT
ROBERT J. SHAW 1991 13 p Proposed for presentation at the 10th International Symposium on Air Breathing Engines, Nottingham, England, 1-6 Sep. 1991; sponsored by AIAA
(NASA-TM-104363; E-6159; NAS 1.15:104363) Avail: NTIS HC/MF A03 CSCL 01/3

Recent NASA funded studies by Boeing and Douglas suggest an opportunity exists for a 21st Century High Speed Civil Transport (HSCT) to become part of the international air transportation system. However, before this opportunity for high speed travel can be realized, certain environmental and and economic barrier issues must be overcome. These challenges are outlined. Research activities which NASA has planned to address these barrier issues and to provide a technology base to allow U.S. manufacturers to make an informed go/no go decision on developing the HSCT are discussed. Author

N91-23099*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
MICROWAVE LANDING SYSTEM MODELING WITH APPLICATION TO AIR TRAFFIC CONTROL
M. M. POULOSE Apr. 1991 23 p
(NASA-TM-102832; A-90184; NAS 1.15:102832) Avail: NTIS HC/MF A03 CSCL 01/3

Compared to the current instrument landing system, the microwave landing system (MLS), which is in the advanced stage of implementation, can potentially provide significant fuel and time savings as well as more flexibility in approach and landing functions. However, the expanded coverage and increased accuracy requirements of the MLS make it more susceptible to the features of the site in which it is located. An analytical approach is presented for evaluating the multipath effects of scatterers that are commonly found in airport environments. The approach combines a multiplane model with a ray-tracing technique and a formulation for estimating the electromagnetic fields caused by the antenna array in the presence of scatterers. The model is applied to several airport scenarios. The reduced computational burden enables the scattering effects on MLS position information to be evaluated in near real time. Evaluation in near real time would permit the incorporation of the modeling scheme into air traffic control automation; it would adaptively delineate zones of reduced accuracy within the MLS coverage volume, and help establish safe approach and takeoff trajectories in the presence of uneven terrain and other scatterers. Author

N91-23100# Army Aeromedical Research Lab., Fort Rucker, AL.
A TEST OF THE AMERICAN SAFETY FLIGHT SYSTEMS, INC. PREBREATHER/PORTABLE OXYGEN SYSTEM Final Report
ROBERT L. STEPHENS, FRANCIS S. KNOX, ROBERT A. MITCHELL, and VADANKUMAR M. PATEL Jan. 1991 27 p
(Contract DA PROJ. 3E1-62787-A-878)
(AD-A232723; USAARL-91-5) Avail: NTIS HC/MF A03 CSCL 14/2

In response to a request from the Aviation Life Support Equipment Product Manager (ALSE-PM) of the Aviation Systems Command (AVSCOM), the U.S. Army Aeromedical Research Laboratory (USAARL) conducted an investigation and evaluation of the Prebreather/Portable Oxygen System (P/POS) manufactured by American Safety Flight Systems, Inc. A test of the P/POS was conducted in the hypobaric chamber at the U.S. Army School of Aviation Medicine. Four crews of four subjects each and one crew of three (the last crew had only three because one subject had a middle ear infection) prebreathed 100 percent chamber oxygen for 30 minutes. Then they switched to the P/POS while the chamber was depressurized to 18,000 feet MSL at a rate of 500 fpm. They remained at this altitude pressure until they reduced the P/POS pressure from 1800 psi to 200 psi. Following this, the chamber was repressurized to sea level at a rate of 4000 fpm. Mission durations, percent oxygen saturation and cognitive performance were measured for each subject. The average mission duration was 2 hr 28 min with a standard deviation of 13.9 min. The study indicated the P/POS will meet the needs of all helicopter missions for the Army that do not require prebreathing. GRA

N91-24140*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AIRBORNE WIND SHEAR DETECTION AND WARNING SYSTEMS: THIRD COMBINED MANUFACTURERS' AND TECHNOLOGISTS' CONFERENCE, PART 2
DAN D. VICROY, comp., ROLAND L. BOWLES, comp., and HERBERT SCHLICKENMAIER, comp. (Federal Aviation Administration, Washington, DC.) Jan. 1991 464 p Conference held in Hampton, VA, 16-18 Oct. 1990 Prepared in cooperation with Federal Aviation Administration, Washington, DC
(NASA-CP-10060-PT-2; NAS 1.55:10060-PT-2;
DOT/FAA/RD-91/2-PT-2) Avail: NTIS HC/MF A20 CSCL 01/3

The Third Combined Manufacturers' and Technologists' Conference was held in Hampton, Va., on October 16-18, 1990. The purpose of the meeting was to transfer significant on-going results of the NASA/FAA joint Airborne Wind Shear Program to the technical industry and to pose problems of current concern to the combined group. It also provided a forum for manufacturers to review forward-look technology concepts and for technologists to gain an understanding of the problems encountered by the manufacturers during the development of airborne equipment and the FAA certification requirements.

N91-24141*# Lockheed Missiles and Space Co., Palo Alto, CA.
CLASS: COHERENT LIDAR AIRBORNE SHEAR SENSOR. WINDSHEAR AVOIDANCE
RUSSELL TARG *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 p 509-526 Jan. 1991
(LMSC-F-415048) Avail: NTIS HC/MF A20 CSCL 01/3

The coherent lidar airborne shear sensor (CLASS) is an airborne CO2 lidar system being designed and developed by Lockheed Missiles and Space Company, Inc. (LMSC) under contract to NASA Langley Research Center. The goal of this program is to develop a system with a 2- to 4-kilometer range that will provide a warning time of 20 to 40 seconds, so that the pilot can avoid the hazards of low-altitude wind shear under all weather conditions. It is a

predictive system which will warn the pilot about a hazard that the aircraft will experience at some later time. The ability of the system to provide predictive warnings of clear air turbulence will also be evaluated. A one-year flight evaluation program will measure the line-of-sight wind velocity from a wide variety of wind fields obtained by an airborne radar, an accelerometer-based reactive wind-sensing system, and a ground-based Doppler radar. The success of the airborne lidar system will be determined by its correlation with the windfield as indicated by the onboard reactive system, which indicates the winds actually experienced by the NASA Boeing 737 aircraft. Author

N91-24142*# Ophir Corp., Lakewood, CO.
CONTINUOUS WAVE LASER FOR WIND SHEAR DETECTION
LOREN NELSON *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 p 527-554 Jan. 1991
Avail: NTIS HC/MF A20 CSCL 01/3

Details of the design and development of a continuous-wave heterodyne carbon dioxide laser which has wind shear detection capabilities are given in viewgraph form. The goal of the development was to investigate the lower cost CW (rather than pulsed) lidar option for look-ahead wind shear detection from aircraft. The device has potential utility for ground based wind shear detection at secondary airports where the high cost of a Terminal Doppler Weather Radar system is not justifiable. Author

N91-24143*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
STATUS OF 2 MICRON LASER TECHNOLOGY PROGRAM
MARK STORM *In its* Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 p 555-576 Jan. 1991
Avail: NTIS HC/MF A20 CSCL 01/3

The status of 2 micron lasers for windshear detection is described in viewgraph form Theoretical atmospheric and instrument system studies have demonstrated that the 2.1 micron Ho:YAG lasers can effectively measure wind speeds in both wet and dry conditions with accuracies of 1 m/sec. Two micron laser technology looks very promising in the near future, but several technical questions remain. The Ho:YAG laser would be small, compact, and efficient, requiring little or no maintenance. Since the Ho:YAG laser is laser diode pumped and has no moving part, the lifetime of this laser would be directly related to the diode laser lifetimes which can perform in excess of 10,000 hours. Efficiencies of 3 to 12 percent are expected, but laser demonstrations confirming the ability to Q-switch this laser are required. Coherent laser operation has been demonstrated for both the CW and Q-switched lasers. Author

N91-24144*# Litton Aero Products, Moorpark, CA.
AVIONIC LASER MULTISENSOR PROGRAM AT LITTON AERO PRODUCTS
ROD BENOIST and FARZIN AMZAJERDIAN *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 p 577-586 Jan. 1991
Avail: NTIS HC/MF A20 CSCL 01/3

Information on the Avionic Laser Multisensor program at Litton Aero Products is given in viewgraph form. Included are project goals, potential avionic applications, and future work. Author

N91-24145*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
STATUS OF NASA'S IR WIND SHEAR DETECTION RESEARCH
BURNELL MCKISSICK *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 p 589-608 Jan. 1991
Avail: NTIS HC/MF A20 CSCL 01/3

The status of NASA's wind shear detection research is reported in viewgraph form. Information is given on early experience, FLIR detectors, quantities measured by Airborne Warning and Avoidance System 1 (AWAS 1), the time series model for Flight 551, conclusions from NASA 737 flights, conclusions on Orlando 7-7-90, and AWAS 3 mnemonics. Author

N91-24146*# Turbulence Prediction Systems, Boulder, CO.
STATUS OF TURBULENCE PREDICTION SYSTEM'S AWAS 3
PAT ADAMSON *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 p 609-635 Jan. 1991
Avail: NTIS HC/MF A20 CSCL 01/3

The status of the Airborne Warning and Avoidance System 3 (AWAS 3) is reported in viewgraph form. Information is given on flight tests and FAA certification. Included is a description of the flight test of a passive infrared system that achieved the first ever advanced warning of an in-flight windshear encounter. The infrared system recorded the detection of the windshear with a 35 second advance warning. The data recorded in-flight by the infrared system was later compared to and found to agree with the data recorded by the Terminal Doppler Weather Radar (TDWR) and the in-situ air data. Author

N91-24147*# Colorado State Univ., Fort Collins.
AN AIRBORNE FLIR DETECTION AND WARNING SYSTEM FOR LOW ALTITUDE WIND SHEAR
PETER C. SINCLAIR and PETER M. KUHN (Aries Corp., McLean, VA.) *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 p 637-677 Jan. 1991
Submitted for publication
Avail: NTIS HC/MF A20 CSCL 01/3

It is shown through some preliminary flight measurement research that a forward looking infrared radiometer (FLIR) system can be used to successfully detect the cool downdraft of downbursts (microbusts/macrobursts) and thunderstorm gust front outflows that are responsible for most of the low altitude wind shear (LAWS) events. The FLIR system provides a much greater safety margin for the pilot than that provided by reactive designs such as inertial air speed systems. Preliminary results indicate that an advanced airborne FLIR system could provide the pilot with remote indication of microburst (MB) hazards along the flight path ahead of the aircraft. Results of a flight test of a prototype FLIR system show that a minimum warning time of one to four minutes (5 to 10 km), depending on aircraft speed, is available to the pilot prior to the microburst encounter. Author

N91-24149*# Westinghouse Defense and Electronic Systems Center, Baltimore, MD. Radar Systems Engineering.
SABERLINER FLIGHT TEST FOR AIRBORNE WIND SHEAR FORWARD LOOKING DETECTION AND AVOIDANCE RADAR SYSTEMS
BRUCE D. MATHEWS *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 p 713-754 Jan. 1991
Avail: NTIS HC/MF A20 CSCL 01/3

Westinghouse conducted a flight test with its Sabreliner AN/APG-68 instrumented radar to assess the urban discrete/ground moving vehicle clutter environment. Glideslope approaches were flown into Washington National, BWI, and Georgetown, Delaware, airports employing radar mode timing, waveform, and processing configurations plausible for microburst windshear avoidance. The perceptions, both general and specific, of the clutter environment furnish an empirical foundation for beginning low false alarm detection algorithm development. Author

N91-24151*# Rockwell International Corp., Cedar Rapids, IA. Air Transport Div.
WIND SHEAR RADAR PROGRAM FUTURE PLANS

ROY E. ROBERTSON *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 p 767-781 Jan. 1991
Avail: NTIS HC/MF A20 CSCL 01/3

The status of the Windshear Radar Program at the Collins Air Transport Division of Rockwell International is given in viewgraph form. Topics covered include goals, modifications to the WXR-700 system, flight test plans, technical approaches, design considerations, system considerations, certification, and future plans. Author

N91-24152*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
CLUTTER MODELING OF THE DENVER AIRPORT AND SURROUNDING AREAS
STEVEN D. HARRAH, VICTOR E. DELMORE, and ROBERT G. ONSTOTT (Environmental Research Inst. of Michigan, Ann Arbor.) *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 p 783-836 Jan. 1991
Avail: NTIS HC/MF A20 CSCL 01/3

To accurately simulate and evaluate an airborne Doppler radar as a wind shear detection and avoidance sensor, the ground clutter surrounding a typical airport must be quantified. To do this, an imaging airborne Synthetic Aperture Radar (SAR) was employed to investigate and map the normalized radar cross sections (NRCS) of the ground terrain surrounding the Denver Stapleton Airport during November of 1988. Images of the Stapleton ground clutter scene were obtained at a variety of aspect and elevation angles (extending to near-grazing) at both HH and VV polarizations. Presented here, in viewgraph form with commentary, are the method of data collection, the specific observations obtained of the Denver area, a summary of the quantitative analysis performed on the SAR images to date, and the statistical modeling of several of the more interesting stationary targets in the SAR database. Additionally, the accompanying moving target database, containing NRCS and velocity information, is described. Author

N91-24153*# Research Triangle Inst., Newport News, VA.
RADAR SIMULATION PROGRAM UPGRADE AND ALGORITHM DEVELOPMENT
CHARLES L. BRITT *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 p 839-867 Jan. 1991
(Contract NAS1-18925)
Avail: NTIS HC/MF A20 CSCL 01/3

The NASA Radar Simulation Program is a comprehensive calculation of the expected output of an airborne coherent pulse Doppler radar system viewing a low level microburst along or near the approach path. Inputs to the program include the radar system parameters and data files that contain the characteristics of the microbursts to be simulated, the ground clutter map, and the discrete target data base which provides a simulation of the moving ground clutter. For each range bin, the simulation calculates the received signal amplitude level by integrating the product of the antenna gain pattern and the scattering source amplitude and phase of a spherical shell volume segment defined by the pulse width, radar range, and ground plane intersection. A series of in-phase and quadrature pulses are generated and stored for further processing if desired. In addition, various signal processing techniques are used to derive the simulated velocity and hazard measurements, and store them for use in plotting and display programs. Author

N91-24154*# Clemson Univ., SC. Radar Systems Lab.
SIGNAL PROCESSING TECHNIQUES FOR CLUTTER FILTERING AND WIND SHEAR DETECTION
ERNEST G. BAXA, JR. and MANOHAR D DESHPANDE *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 p 869-911 Jan. 1991
Avail: NTIS HC/MF A20 CSCL 01/3

An extended Prony algorithm applicable to signal processing techniques for clutter filtering and windshear detection is discussed. The algorithm is based upon modelling the radar return as a time series, and appears to offer potential for improving hazard factor estimates in the presence of strong clutter returns. Author

N91-24155*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AIRBORNE RADAR SIMULATION STUDIES OF THE DENVER JULY 11, 1988 MICROBURST
CHARLES L. BRITT (Research Triangle Inst., Newport News, VA.) and E. M. BRACALENTE *In its* Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 p 913-936 Jan. 1991
Avail: NTIS HC/MF A20 CSCL 01/3

In the simulation program, a wind shear detection Doppler radar was placed in UAL 395 and 236 aircraft and flown along their landing flight paths. The microburst was placed at the appropriate location and intensity corresponding to each aircraft's landing approach time. A baseline set of radar design parameters were used in the simulation. Output display information and wind shear detection processing was produced as the aircraft approached the microburst. Information on the results of the simulation study are given in graphical form. Author

N91-24156*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DESCRIPTION, CHARACTERISTICS AND TESTING OF THE NASA AIRBORNE RADAR
W. R. JONES, O. ALTIZ, P. SCHAFFNER, J. H. SCHRADER (Research Triangle Inst., Newport News, VA.), and H. J. C. BLUME *In its* Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 2 p 937-978 Jan. 1991
Avail: NTIS HC/MF A20 CSCL 01/3

Presented here is a description of a coherent radar scattermeter and its associated signal processing hardware, which have been specifically designed to detect microbursts and record their radar characteristics. Radar parameters, signal processing techniques and detection algorithms, all under computer control, combine to sense and process reflectivity, clutter, and microburst data. Also presented is the system's high density, high data rate recording system. This digital system is capable of recording many minutes of the in-phase and quadrature components and corresponding receiver gains of the scattered returns for selected spatial regions, as well as other aircraft and hardware related parameters of interest for post-flight analysis. Information is given in vlewgraph form. Author

N91-24157# Wichita State Univ., KS. National Inst. for Aviation Research.
PROGRAM PLANS FOR AVIATION SAFETY RESEARCH
WILLIAM H. WENTZ, JOHN J. HUTCHINSON, BEHNAM BAHR, WAYNE BECKER, WALTER BERNHART, RANDALL M. CHAMBERS, RICHARD CHANDLER (Federal Aviation Administration, Atlantic City, NJ.), THOMAS K. DELILLO, DAVID ELLIS, JAMES HO et al. Dec. 1990 62 p
(Contract DTFA03-90-C-00050)
(NIAR-90-32) Avail: NTIS HC/MF A04

The National Institute for Aviation research at the Wichita State University is conducting research in aviation safety for the Federal Aviation Administration (FAA). The research activities are in the three major areas of aging aircraft, crashworthiness and structural integrity, and human factors. Specific topics include crack detection in aircraft structures, scratch effects on fatigue of new alloys, crash analysis of aircraft seats, paint removal for composite aircraft structures, freeze/thaw damage to composites, and single pilot instrument flight rules (IFR) operations.

N91-24161# Wichita State Univ., KS.
CRASHWORTHINESS EXPERIMENTS

WAYNE BERNHART, HOWARD SMITH, RICHARD CHANDLER, and JOSEPH MITCHELL *In its* Program Plans for Aviation Safety Research 6 p Dec. 1990
Avail: NTIS HC/MF A04

The Wichita State University purchased a horizontal impact sled. The sled is currently being subjected to various acceptance tests. The primary objective of this research program is to complete the development of a total dynamic test capability to support elements of the aircraft industry in meeting future and present FAA regulatory standards. The FAA has developed these regulatory standards for seats and restraint systems and is expected to issue new standards for various aircraft components. It is anticipated that the FAA will conduct various dynamic tests in this laboratory in support of their own program in crashworthiness. Author

N91-24166*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AIRBORNE WIND SHEAR DETECTION AND WARNING SYSTEMS: THIRD COMBINED MANUFACTURERS' AND TECHNOLOGISTS' CONFERENCE, PART 1
DAN D. VICROY, comp., ROLAND L. BOWLES, comp., and HERBERT SCHLICKENMAIER, comp. (Federal Aviation Administration, Washington, DC.) Jan. 1991 490 p Conference held in Hampton, VA, 16-18 Oct. 1990 Prepared in cooperation with FAA, Washington, DC
(NASA-CP-10060-PT-1; NAS 1.55:10060-PT-1;
DOT/FAA/RD-91/2-PT-1) Avail: NTIS HC/MF A21 CSCL 14/2

Papers presented at the conference on airborne wind shear detection and warning systems are compiled. The following subject areas are covered: terms of reference; case study; flight management; sensor fusion and flight evaluation; Terminal Doppler Weather Radar data link/display; heavy rain aerodynamics; and second generation reactive systems.

N91-24167*# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
LIDAR STUDIES ON MICROBURSTS
Y. AURENCHE and J. L. BOULAY *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 p 29-35 Jan. 1991
Avail: NTIS HC/MF A21 CSCL 14/2

Preliminary analysis of requirements for future airborne windshear detection systems is presented. The following topics are covered: flight mechanics; microbursts modeling; microburst detection with airborne systems (LIDAR, radar, passive IR sensors); microbursts prediction with ground systems (VHF interferometry). A short overview of these studies is presented and some results are discussed. Author

N91-24168*# Service Technique de la Navigation Aerienne, Paris (France).
RADAR PERFORMANCE EXPERIMENTS
C. LEROUX, F. BERTIN, and H. MOUNIR (Centre National d'Etudes des Telecommunications, Saint Maur des Fosses, France) *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 p 37-54 Jan. 1991
Avail: NTIS HC/MF A21 CSCL 14/2

Theoretical studies and experimental results obtained at Coulommiers airport showed the capability of Proust radar to detect wind shears, in clear air condition as well as in presence of clouds or rain. Several examples are presented: in a blocking highs situation an atmospheric wave system at the Brunt-Vaisala frequency can be clearly distinguished; in a situation of clouds without rain the limit between clear air and clouds can be easily seen; and a windshear associated with a gust front in rainy conditions is shown. A comparison of 30 cm clear air radar Proust and 5 cm weather Doppler radar Ronsard will allow to select the best candidate for wind shear detection, taking into account the low sensibility to ground clutter of Ronsard radar. Author

N91-24169*# Remtech, S.A., Paris (France).
MEGASODAR EXPERIMENT
ALAIN DONZIER *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 p 57-59 Jan. 1991
Avail: NTIS HC/MF A21 CSCL 14/2

SODAR application to wind shear and wake vortex detection is described. A commercial phase array SODAR line was developed and operated at Roissy International Airport for a few days. Some radial wind data are presented. Even though this system was not optimized for such application, it showed ranges of about 800 m for an averaging time of 10 min and an elevation angle of 20 deg. Some strong echo regions are present in the data and seem to be related to wake vortex. Author

N91-24172*# Massachusetts Inst. of Tech., Cambridge.
MICROBURST AVOIDANCE SIMULATION TESTS
JOHN HANSMAN *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 p 107-141 Jan. 1991
Avail: NTIS HC/MF A21 CSCL 01/3

Implementation issues for uplinked microburst alerts are presented in the form of view-graphs. The following topics are covered: evaluation, transmission, and presentation of ground-based Doppler weather radar derived information through a limited bandwidth digital data link; electronic cockpit presentation of uplinked wind shear alerts (pilot opinion survey, part-task simulation experiment); presentation modes (verbal, textual, and graphical); and ground evaluation of ground-measures wind shear data. Author

N91-24173*# Flight Safety Foundation, Inc., Arlington, VA.
WIND SHEAR TRAINING APPLICATIONS FOR 91/135
ED ARBON *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 p 143-152 Jan. 1991
Avail: NTIS HC/MF A21 CSCL 01/3

The requirement for wind shear training of all pilots has been demonstrated too often by the accident statistics of past years. Documents were developed to train airline crews on specific aircraft and to teach recognition of the meteorological conditions that are conducive to wind shear and microburst formation. A Wind Shear Training Aid program is discussed. Author

N91-24174*# Honeywell, Inc., Phoenix, AZ. Commercial Flight Systems Group.
INTEGRATION OF WEATHER SENSING DEVICES
JIM DAILY *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 p 177-199 Jan. 1991
Avail: NTIS HC/MF A21 CSCL 01/3

The state of airborne atmospheric sensing is continually evolving as devices are developed which further enhance the detection of meteorological phenomena. Assuming that these technologies prove to be feasible, the greatest long-term benefit would be attained by effective integration of the various sensors. A system which could accomplish this goal would conceivably provide enhanced atmospheric analysis, coherent display capability, and would allow for the development of expert system to predict weather conditions. The existing and developing weather detection technologies are presented, followed by an overview of what issues must be dealt with in the creation of an integrated system. A framework of a basic system is also presented which identifies some of the potential applications that exist. Author

N91-24175*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NASA LANGLEY FLIGHT TEST PROGRAM
MIKE LEWIS *In its* Airborne Wind Shear Detection and Warning

Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 p 201-224 Jan. 1991
Avail: NTIS HC/MF A21 CSCL 01/3

General overview of NASA/Langley Research Center wind shear flight project is presented in the form of view-graphs. The following subject areas are covered: program elements (hazard characterization, sensor technology, and flight management systems); flight test objective; facility; flight requirements; flight operations; and status/schedule. Author

N91-24176*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TDWR INFORMATION ON THE FLIGHT DECK
DAVE HINTON *In its* Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 p 227-242 Jan. 1991
Avail: NTIS HC/MF A21 CSCL 01/3

TDWR information on the flight deck is presented in the form of view-graphs. The following subject areas are covered: air/ground wind shear information integration research; wind shear detection/warning and avoidance system; initial experiment; and future plans. Author

N91-24177*# Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
ORLANDO EXPERIMENT
STEVE CAMPBELL *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 p 243-262 Jan. 1991
Avail: NTIS HC/MF A21 CSCL 01/3

FAA terminal Doppler weather radar program and NASA/FAA airborne wind shear program are presented in the form of view-graphs. The following topics are included: TDWR testbed radar performance; cockpit display system; flight operations; analysis workstation; and future work. Author

N91-24178*# National Center for Atmospheric Research, Boulder, CO.
INTEGRATION OF THE TDWR AND LLWAS WIND SHEAR DETECTION SYSTEM
LARRY CORNMAN *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 p 263-297 Jan. 1991
Avail: NTIS HC/MF A21 CSCL 01/3

Operational demonstrations of a prototype TDWR/LLWAS (Terminal Doppler Weather Radar/Low Level Wind shear Alarm System) integrated wind shear detection system were conducted. The integration of wind shear detection systems is needed to provide end-users with a single, consensus source of information. A properly implemented integrated system provides wind shear warnings of a higher quality than stand-alone LLWAS or TDWR systems. The algorithmic concept used to generate the TDWR/LLWAS integrated products and several case studies are discussed, indicating the viability and potential of integrated wind shear detection systems. Implications for integrating ground and airborne wind shear detection systems are briefly examined. Author

N91-24179*# Mitre Corp., McLean, VA.
THERMODYNAMIC ALERTER FOR MICROBURSTS (TAMP)
PETER J. ECCLES *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 p 351-363 Jan. 1991
Avail: NTIS HC/MF A21 CSCL 01/3

The following subject areas are covered: microburst detection, location and measurement; thermal alerter for microbursts prototypes (TAMP); sensor-transmitters (Senstrans) design; TAMP installation; and DAPAD software. Author

N91-24180*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
STATUS OF HEAVY RAIN TESTS
GAUDY BEZOS *In its* Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 p 367-393 Jan. 1991
Avail: NTIS HC/MF A21 CSCL 01/3

The heavy rain effects program is presented in the form of the view-graphs. The following topics are covered: rain effects on airfoil performance; two-phase flow dynamics; wind tunnel test results; issues; large-scale results; and summary. Author

N91-24182*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ESTIMATE OF HEAVY RAIN PERFORMANCE EFFECT
DAN D. VICROY *In its* Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 p 425-450 Jan. 1991
Avail: NTIS HC/MF A21 CSCL 01/3

The aerodynamic effect of heavy rain on airplane performance is presented in the form of view-graphs. The following subject areas are covered: review of heavy rain airfoil tests; development of heavy rain aerodynamic model for a twin-jet transport; performance analysis with heavy rain effects; numeric simulation of wet microburst encounter; and summary of results and future needs. Author

N91-24183*# Sundstrand Data Control, Inc., Redmond, WA.
STATUS OF SUNDSTRAND RESEARCH
DON BATEMAN *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 p 453-477 Jan. 1991
Avail: NTIS HC/MF A21 CSCL 01/3

Wind shear detection status is presented in the form of view-graphs. The following subject areas are covered: second generation detection (Q-bias, gamma bias, temperature biases, maneuvering flight modulation, and altitude modulation); third generation wind shear detection (use wind shear computation to augment flight path and terrain alerts, modulation of alert thresholds based on wind/terrain data base, incorporate wind shear/terrain alert enhancements from predictive sensor data); and future research and development. Author

N91-24184*# Honeywell, Inc., Phoenix, AZ. Commercial Flight Systems Div.
TEMPERATURE LAPSE RATE AS AN ADJUNCT TO WIND SHEAR DETECTION
TERRY ZWEIFIL *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 p 479-495 Jan. 1991
Avail: NTIS HC/MF A21 CSCL 01/3

Several meteorological parameters were examined to determine if measurable atmospheric conditions can improve windshear detection devices. Lapse rate, the temperature change with altitude, shows promise as being an important parameter in the prediction of severe wind shears. It is easily measured from existing aircraft instrumentation, and it can be important indicator of convective activity including thunderstorms and microbursts. The meteorological theory behind lapse rate measurement is briefly reviewed, and and FAA certified system is described that is currently implemented in the Honeywell Wind Shear Detection and Guidance System. Author

N91-24185# Computer Resource Management, Inc., Herndon, VA.
NATIONAL AIRSPACE SYSTEM. COMMUNICATIONS OPERATIONAL CONCEPT NAS-SR-136
WILLIAM TRENT, THOMAS PICKERELL, and HAROLD NELSON May 1991 68 p
(Contract DTFA01-91-Y-01004)
(DOT/FAA/SE-91/1) Avail: NTIS HC/MF A04

A requirement of the National Airspace System (NAS) is to provide for communications, as identified in the NAS Requirement Specification, NAS-SR-1000 (NASSRS). A concept of operation for air-ground, ground-ground communications connectivity and capability, and national emergency communications is presented. This concept describes the capabilities and shows the relationships between subsystems, facilities, information, and operators/users. It is intended to provide a common perspective for personnel involved in communication activities, assist in determining whether communications meet formal requirements, and support coordination among the organizations involved. This concept is one of eight operational concepts. The remaining yet to be written concepts will complete the description of the system requirements as detailed in the NASSRS. Author

N91-24186# Royal Aerospace Establishment, Farnborough (England).
LIGHTNING PROTECTION REQUIREMENTS FOR AIRCRAFT: A PROPOSED SPECIFICATION
G. A. M. ODAM, A. W. HANSON, and R. H. EVANS (Halarose Ltd., England) 25 Oct. 1990 147 p Revised
(RAE-TM-FS(F)-632-ISSUE-1-REV; BR116373; ETN-91-99331; AD-A233712) Copyright Avail: NTIS HC/MF A07

A Royal Aerospace recommendation for a specification to define the United Kingdom Ministry of Defense (UK MOD) requirements for the lightning protection of aircraft is presented. It is an appendix to a JAC paper proposing changes to the lightning content of DEF STAN 00-970. This issue covers background and advisory material, certification, design, and testing requirements. It applies to all fixed and rotary wing aircraft. ESA

N91-24187# Army Aeromedical Research Lab., Fort Rucker, AL.
THE AIRBAG AS A SUPPLEMENT TO STANDARD RESTRAINT SYSTEMS IN THE AH-1 AND AH-64 ATTACK HELICOPTERS AND ITS ROLE IN REDUCING HEAD STRIKES OF THE COPILOT/GUNNER, VOLUME 2 Final Report
NABIH M. ALEM, DENNIS F. SHANAHAN, and JOHN V. BARSON Jan. 1991 162 p
(AD-A232907; USAARL-91-6-VOL-2) Avail: NTIS HC/MF A08
CSCL 01/3

Accident investigation records of U.S. Army helicopter crashes show injuries of pilots due to striking a structure inside the cockpit outnumber those due to excessive accelerations by a five-to-one ratio. This two-volume report presents the results of a study of the effectiveness of airbags in reducing the severity of contact injury to the gunner when striking the gunsight. Airbag systems were installed on the gunsights in simulated Cobra and Apache cockpits, then sled tested at 7 and 25 g. The tests indicated airbags reduced head accelerations by 65 percent, head injury criteria by 77 percent, and head angular acceleration by 76 percent in the Cobra tests. In the Apache tests, the airbags reduced those same indicators by 68, 52, and 83 percent. An airbag system, the report concludes, is likely to prevent severe or fatal head and chest injuries in an Apache or Cobra crash. Volume 1 of the report describes the tests and discusses the results. Volume 2 consists of Appendixes A, B, and C of the report and contains processed signal graphs of all sled tests. GRA

N91-24188# Army Aeromedical Research Lab., Fort Rucker, AL.
THE AIRBAG AS A SUPPLEMENT TO STANDARD RESTRAINT SYSTEMS IN THE AH-1 AND AH-64 ATTACK HELICOPTERS AND ITS ROLE IN REDUCING HEAD STRIKES OF THE COPILOT/GUNNER, VOLUME 1 Final Report
NABIH M. ALEM, DENNIS F. SHANAHAN, JOHN V. BARSON, and WILLIAM H. MUZZY, III Jan. 1991 50 p
(Contract DA PROJ. 3M1-62787-A-878)
(AD-A233349; USAARL-91-6-VOL-1) Avail: NTIS HC/MF A03
CSCL 01/3

Accident investigation records of U.S. Army helicopter crashes show injuries of pilots due to striking a structure inside the cockpit outnumber those due to excessive accelerations by a five-to-one ratio. This two-volume reports presents the results of a study of the effectiveness of airbags in reducing the severity of contact injury to the gunner when striking the gunsight. Airbag systems were installed on the gunsights in simulated Cobra and Apache cockpits, then sled tested at 7 and 25 g. The tests indicated airbags reduced head accelerations by 65 pct. head injury criteria by 77 pct. and head angular acceleration by 76 pct. in the Cobra tests. In the Apache tests, the airbags reduced those same indicators by 68, 52, and 83 pct. It is concluded that an airbag system works very well. Volume 1 of the report describes the tests and discusses the results. GRA

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

A91-37094
RELATIVE EFFECTIVENESS OF 2-D VS. 1-D HIGH RESOLUTION MICROWAVE IMAGEING
BERNARD D. STEINBERG and BONGSOON KANG (Pennsylvania, University, Philadelphia) IN: Noise and clutter rejection in radars and imaging sensors; Proceedings of the 2nd International Symposium, Kyoto, Japan, Nov. 14-16, 1989. Amsterdam, Elsevier Science Publishers, 1990, p. 142-147. Research supported by USAF and U.S. Army. refs
Copyright

The relative effectiveness of two-dimensional and one-dimensional high-resolution microwave imaging is evaluated, with preliminary comparison results presented for the Boeing 727 and the widebodied L-1011. Data were obtained at X-band as the aircraft were flying into Philadelphia International Airport. The data-acquisition radar was a low-power 1250-W-peak short-pulse fully coherent radar. The results indicate that it is as yet unwarranted to conclude that one-dimensional imaging is relatively useless for target identification. L.M.

A91-37101
EVOLUTION OF CLUTTER SUPPRESSION TECHNIQUES FOR AIR TRAFFIC CONTROL AND SURVEILLANCE RADAR
GASPARE GALATI (Roma II, Universita, Rome, Italy) IN: Noise and clutter rejection in radars and imaging sensors; Proceedings of the 2nd International Symposium, Kyoto, Japan, Nov. 14-16, 1989. Amsterdam, Elsevier Science Publishers, 1990, p. 257-262. refs
Copyright

The problem of suppressing clutter while maintaining the detection capability of aircraft targets is of paramount importance for air traffic control radars. This paper deals with the most popular suppression method, i.e., discriminating clutter from moving targets by Doppler filtering. The development of valuable clutter filtering techniques and of the pertinent processing schemes is reviewed. Some pitfalls related to incorrect use of intuition (instead of the underlying, well-established theory corroborated by field experience) are also described. The overall evolution of the ATC radar is also reviewed, including future trends. Author

A91-37107
ALL SOLID-STATE ASR WITH ADAPTIVE PULSE DOPPLER PROCESSING
EIICHI KIUCHI, HIROSHI NAKAMURA, and TOSHIHIKO HAGISAWA (NEC Corp., Radio Application Div., Fuchu, Japan) IN: Noise and clutter rejection in radars and imaging sensors; Proceedings of the 2nd International Symposium, Kyoto, Japan, Nov. 14-16, 1989. Amsterdam, Elsevier Science Publishers, 1990, p. 293-298.
Copyright

An all solid-state ASR employing a pulse Doppler processor

adaptable to each clutter area and capable of supplying analog video with smoothed blips has been developed. The high subclutter visibility provided by pulse Doppler processing is combined with the azimuth accuracy of a conventional MTI. The new ASR promises better target detectability for small aircraft in a clutter environment, with better reliability and maintainability than conventional radars. A.F.S.

A91-37121
SSR SIGNAL DISCRIMINATION FROM GARBLED REPLIES
KAKUICHI SHIOMI and TORAO ISHIBASHI (Ministry of Transport, Electronic Navigation Research Institute, Mitaka, Japan) IN: Noise and clutter rejection in radars and imaging sensors; Proceedings of the 2nd International Symposium, Kyoto, Japan, Nov. 14-16, 1989. Amsterdam, Elsevier Science Publishers, 1990, p. 397-402.
Copyright

A new method for discriminating garbled SSR (Secondary Surveillance Radar) replies is described. By using two SSR receiving stations and analyzing received signals from aircraft, the SSR identification of aircraft is made for the garbled replies. The results of the simulation show that aircraft has been identified about 90 percent of cases by this method when two replies are garbled. Author

A91-37139
ADAPTIVE AIRBORNE TRACK WHILE SCAN
DAVID CALUGI and ALDO RICCOBONO (Segnalamento Marittimo ed Aereo S.p.A., Florence, Italy) IN: Noise and clutter rejection in radars and imaging sensors; Proceedings of the 2nd International Symposium, Kyoto, Japan, Nov. 14-16, 1989. Amsterdam, Elsevier Science Publishers, 1990, p. 596-601.
Copyright

This paper presents the track while scan (TWS) systems adopted on airborne radar for tracking of naval targets. The filter adopted is an adaptive Kalman, which permits it to support the tracking of targets that are either in a steady state or maneuvering. This TWS technique gives accurate estimations of both the start and termination of target maneuvers as it can select the proper bandwidth of the estimator filter according to the relation between the maneuver and noise intensity. To evaluate both the filtering efficiency and the plot extractor, the geometric operative environment and the radar processing chain are simulated on VAX computers. R.E.P.

A91-37145
EVALUATION OF THE PERFORMANCE OF A RISC BASED REAL TIME DATA PROCESSOR IN AIR TRAFFIC CONTROL RADAR APPLICATIONS
PIERCARLO GIUSTINIANI (Selenia S.p.A., Rome, Italy) IN: Noise and clutter rejection in radars and imaging sensors; Proceedings of the 2nd International Symposium, Kyoto, Japan, Nov. 14-16, 1989. Amsterdam, Elsevier Science Publishers, 1990, p. 638-643.
Copyright

A RISC based architecture developed to perform radar management, parameter extraction, adaptivity control, and clutter/interference rejection in ATC systems is described. Relevant parameters, design criteria, HW/SW allocation of the implemented functions and the SW algorithms are analyzed. This architecture is optimized to process the detections created by a thresholding system applied to a filtered video, but it can be readily utilized in different processing models. The utilization of processor resources in terms of data and program memory occupations and computing power for the different radar functions is shown. R.E.P.

A91-37200
CHARACTERISTICS OF THE RECEPTION BY THE ANTENNA SYSTEMS OF A DESCENDING AIRCRAFT OF SIGNALS FROM RADIO-BEACON LANDING SYSTEMS [OSOBENNOSTI PRIEMA ANTENNYMI SISTEMAMI SNIZHAIUSHCHEGOSIA LETATEL'NOGO APPARATA SIGNALOV OT POSADOCHNYKH RADIOMAIACHNYKH SISTEM]
A. G. KRAVCHENKO and O. K. SHKURUPII Radiotekhnika (Kharkov) (ISSN 0485-8972), no. 91, 1989, p. 100-106. In Russian. refs
Copyright

A theoretical model is developed for characterizing the reception by the antennas of a descending aircraft of radio-beacon signals. It is shown that the intensity of fields arising due to reflection from the ground and the aircraft is significant. The intensity of these fields is directly proportional to the conductivity of the underlying surface and the size of the aircraft. L.M.

A91-38215
AIR TRAFFIC CONTROL TODAY AND TOMORROW
THOMAS STONOR (National Air Traffic Services, London, England) Journal of Navigation (ISSN 0373-4633), vol. 44, May 1991, p. 143-151.
Copyright

An overview is presented of the current ATC situation in and around the UK and how the constantly growing congestion, with its attendant route and airport complications, is being addressed. Among the new systems being introduced, consideration is given to the Microwave Landing System, the Advanced Air Traffic Services system, Mode-S radar technology, Navstar, and the Global Navigation Satellite System. Some of the key issues addressed are the research, development and evaluation of air-ground data link technology, the analysis of improved route structures, airspace sectorization and air traffic procedures, and evaluation for wider application of conflict alert facilities and operational trials of the independent 'last ditch' airborne collision avoidance system. R.E.P.

A91-38217
EUROPEAN STUDIES TO INVESTIGATE THE FEASIBILITY OF USING 1000 FT VERTICAL SEPARATION MINIMA ABOVE FL 290. I
M. E. COX (Eurocontrol, Brussels, Belgium), J. M. TEN HAVE (National Aerospace Laboratory, Amsterdam, Netherlands), and D. A. FORRESTER (Meteorological Office, Bracknell, England) Journal of Navigation (ISSN 0373-4633), vol. 44, May 1991, p. 171-183. refs
Copyright

In response to airline pressures for fuel economies, ICAO established a study program early in the 1980's to determine the feasibility of halving the vertical separation minimum (VSM) utilized above flight level (FL) 290 to 1000 ft. This paper describes a European contribution to this program. The aims and organization of the experimental work are outlined; the choice of methodology available to measure height-keeping errors is described; and an indication of the measurement accuracy achieved is given. It is shown that, whereas it would be technically feasible to introduce a 1000-ft VSM in the North Atlantic region, other measures would be necessary prior to using it in continental airspace. R.E.P.

A91-38322
CURRENT STATUS AND FUTURE PROSPECTS OF AIR TRAFFIC CONTROL [SITUATION ACTUELLE ET FUTURE DU CONTROLE DE LA CIRCULATION AERIENNE]
BERNARD MIALLIER (Eurocontrol, Brussels, Belgium) Navigation (Paris) (ISSN 0028-1530), vol. 39, April 1991, p. 201-209. In French.
Copyright

A review of the current problems confronting air traffic control and the requirements for alleviating this situation is presented. ATC today is significantly constrained by current communication, navigation and surveillance limitations, most of which are the result of unreliable HF communication, line of sight propagation, voice communication that is not conducive to the exchange of diverse and complex data. Planning and coordination for correcting these problems are discussed. It is indicated that improvements between air and ground units can be realized, and an adaptation to traffic demand where automated assistance will help in reducing the control workload per aircraft can be achieved. R.E.P.

A91-38526
ORIENTATION MEASUREMENTS AND TRANSMISSION VIA MODE S AT AIRPORTS [MESSUNGEN ZUR ORTUNG UND UEBERTRAGUNG DURCH MODE S AUF FLUGHAEFEN]
WOLFGANG DETLEFSEN (Braunschweig, Technische Universitaet, Brunswick, Federal Republic of Germany) Ortung und Navigation (ISSN 0474-7550), no. 1, 1991, p. 80-90. In German.
Copyright
The development of an electronic takeoff roll safety system using Mode S is discussed. Test measurements of the system are reported. The effect of the radio field load on the system is addressed. C.D.

A91-38577*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FLIGHT TESTS SHOW POTENTIAL BENEFITS OF DATA LINK AS PRIMARY COMMUNICATION MEDIUM
CHARLES H. SCANLON and CHARLES E. KNOX (NASA, Langley Research Center, Hampton, VA) International Aeronautical Telecommunications Symposium on Data Link Integration, McLean, VA, May 20-23, 1991, Paper. 13 p.
Message exchange for air traffic control (ATC) purposes via data link offers the potential benefits of increasing the airspace system safety and efficiency. This is accomplished by reducing communication errors and relieving the overloaded ATC radio frequencies, which hamper efficient message exchanges during peak traffic periods in many busy terminal areas. However, the many uses and advantages of data link create additional questions concerning the interface among the human-users and the cockpit and ground systems. A flight test was conducted in the NASA Langley B-737 airplane to contrast flight operations using current voice communications with the use of data link for transmitting both strategic and tactical ATC clearances during a typical commercial airline flight from takeoff to landing. Commercial airplane pilots were used as test subjects. Author

A91-39187
FUNCTIONAL-ADAPTIVE DATA PROCESSING IN AIRBORNE RADIO NAVIGATION AND LANDING SYSTEMS [FUNKTSIONAL'NO-ADAPTIVNAIA OBRABOTKA INFORMATSII V BORTOVYKH USTROISTVAKH RADIOSISTEM NAVIGATSII I POSADKI SAMOLETOV]
A. K. BERNIUKOV (Vladimirskii Politekhnicheskii Institut, Vladimir, USSR) Elektronnoe Modelirovanie (ISSN 0204-3572), vol. 13, Mar.-Apr. 1991, p. 8-13. In Russian. refs
Copyright
A method is presented for the functional adaptation of the time-pulse radio navigation and landing systems of aircraft to signal-like and stochastic multibeam reflections from localized and distributed reflectors in airports. The method makes it possible to improve the quality of navigation data with limited a priori noise statistics. An approach to the synthesis of an automatic functional-adaptive digital processor is presented, and synthesis procedures are described. V.L.

A91-39433#
ANGLE-ONLY TRACKING FILTER IN MODIFIED SPHERICAL COORDINATES
DAVID V. STALLARD Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, May-June 1991, p. 694-696. refs
Copyright
The process of choosing an efficient coordinate system for angle-only tracking is extended to three dimensions with modified spherical coordinates. The modified spherical coordinates filter has six state variables: two angles, their derivatives, inverse range, and range rate over range, which are transformable into Cartesian position and velocity. The six-state filter successfully estimates the equivalents of position and velocity in three dimensions for a nonmaneuvering target, using only moderate accelerations of the tracking aircraft. Although the particular application is for 'track-while-scan' by an aircraft, the algorithm could also be used by a homing missile with a faster data rate. P.D.

A91-39756
PULSE DOPPLER SIGNATURE OF A ROTARY-WING AIRCRAFT
BARRY D. BULLARD and PATRICK C. DOWDY (Georgia Institute of Technology, Atlanta) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985), vol. 6, May 1991, p. 28-30.
Copyright
Field measurements of a modified Sikorsky S-55 helicopter target were carried out to investigate rotary-wing aircraft Doppler radar signature phenomenology. The results of the data analysis with regard to classification and identification of the aircraft based on its signature are presented. It was found that using the Doppler radar return and appropriate feature extraction techniques, the helicopter's design features can be estimated. Target backscatter from the main rotor blades, tail rotor blades, or hub can be used for target detection, acquisition, and classification as a rotary-wing aircraft. The extraction of configuration and blade count features can further define the helicopter for identification. I.E.

A91-39776
HIGH GAIN AIRBORNE ANTENNA FOR SATELLITE COMMUNICATIONS
SHINICHI TAIRA, MASATO TANAKA, and SHINGO OHMORI (Communications Research Laboratory, Kashima, Japan) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. 27, March 1991, p. 354-360. refs
Copyright
The performance of an airborne phased-array antenna, which was developed and evaluated onboard a commercial aircraft using the Engineering Test Satellite V (ETS-V), is reported. The system requirements and the antenna configuration that satisfies them are described. The radiation pattern, gain and axial ratio, noise temperature and ratio of gain to noise temperature, and environmental characteristics are presented. The results obtained by the flight experiments demonstrate that the performance of the antenna is the same as that on the ground, so that the antenna is suitable for installation in an aircraft for satellite communications. I.E.

A91-39778
406 MHZ ELT SIGNAL SPECTRA FOR SARSAT
GARY VRCKOVNIK (Defence Research Establishment Ottawa, Canada) and CHARLES R. CARTER (McMaster University, Hamilton, Canada) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. 27, March 1991, p. 388-407. NSERC-supported research. refs
Copyright
The signal format and spectral properties of the 406-MHz emergency locator transmitter (ELT) used in the search and rescue satellite aided tracking (Sarsat) system are examined. The ELT improves location estimate accuracies and can relay information about the particular aircraft and its problem, by means of the digitally modulated message fields. It is shown that due to the RF signal frequency characteristics and the Doppler shift, processing must be performed over a frequency band of approximately 25 kHz. Through the use of the fast Fourier transformation (FFT), the frequency spectrum of the ELT is analyzed, taking account of effects due to noise, multiple simultaneously received signals, and Doppler shift. It is demonstrated that the FFT provides an effective means for detecting and recognizing the presence of one or more ELT signals over this 25-kHz frequency band. Some recommendations are made to improve the spectral characteristics and the performance of the ELT. I.E.

N91-23103# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.). Forschungsbereich Flugmechanik/Flugfuehrung.
FLIGHT MECHANICS/AIR NAVIGATION RESEARCH FIELD. A 1990 SCIENTIFIC REPORT OF THE GERMAN AIR AND SPACE RESEARCH ORGANIZATION Annual Report, 1990 [FORSCHUNGSBEREICH FLUGMECHNIK/FLUGFUEHRUNG, WISSENSCHAFTLICHER BERICHT, STAND 1990]
DOROTHEA KOCH-PETERS, MARIANNE SALEIN, and

ADALBERT TIMME 1990 143 p In GERMAN Original contains color illustrations
(ISSN-0720-7808; ETN-91-99079) Avail: NTIS HC/MF A07

The tasks and aims of both institutes are defined and presented. Flight test data acquisition and analysis, system identification, wind tunnel simulation, real time signal processing are focused upon. The pilot/automatic systems relationship, the design of automatic systems and the improvement of the required sensors are the main concern of air navigation research. The flight safety problems are considered to be solved only when the different navigation aspects on board and on the ground are fully integrated. The Institute of Flight Medicine is described and its aims defined, as well as the Department of Traffic Research, and the Institute for the Dynamics of Flight Systems. ESA

N91-23105# Technische Univ., Brunswick (Germany, F.R.). Inst. fuer Verkehr, Eisenbahnwesen und Verkehrssicherung.
AIRBORNE COLLISION AVOIDANCE SYSTEM (ACAS) IN CONTROLLED AIR TRAFFIC. ASPECTS OF RECIPROCAL INFLUENCE IN SECONDARY SURVEILLANCE RADAR (SSR) RADIO LOADS [BORDKOLLISIONSSCHUTZSYSTEME IM KRONTROLLIERTEN LUFTVERKEHR ASPEKTE GEGENSEITIGER BEEINFLUSSUNG IM SSR FUNKFELD]
ANDREAS HERBER and ROLAND MALLWITZ Nov. 1990 45 p In GERMAN
(ETN-91-99253) Avail: NTIS HC/MF A03

The aim was a qualitative and quantitative evaluation of potential reciprocal influences in secondary surveillance radar (SSR) radio loads. This was made possible by an interpretation of the results of the radio load measurements and by an analysis of existing specifications for the various airborne collision avoidance system (ACAS). Definitive statements are impossible on account of the continuously changing boundary conditions, such as the number of active ground stations. It was shown by the algorithms contained in all II/III ACAS for interference limitations, that the performance realized additionally in the radio loads by all instruments for a maximum of 280 interrogations is limited within a perimeter of 30 nautical miles. It appears differently for ACAS I instruments, where this system is hardly active on account of high interrogation numbers. The observation area is limited to 5 nautical miles. It was concluded that the actions of ACAS II/III on the air traffic control are possible with secondary radar. ESA

N91-23106# Federal Aviation Administration, Atlantic City, NJ.
DIFFERENTIAL GPS TERMINAL AREA TEST RESULTS Technical Report, Nov. 1989 - Nov. 1990
L. F. PERSELLO Nov. 1990 61 p
(AD-A232668; DOT/FAA/CT-TN90/48) Avail: NTIS HC/MF A04 CSCL 17/7

This report describes flight tests conducted by the Federal Aviation Administration (FAA) Technical Center to examine the performance of the Differential Global Positioning System (DGPS) in the terminal area. The tests employed a Convair 580 (CV-580) and a pair of Motorola Eagle Mini Rangers. With the advent of a maturing Global Positioning System (GPS) constellation, the FAA is assuming a more intensive stance in addressing the many questions/problems associated with GPS. These DGPS tests investigated the obtainable accuracy under static and dynamic conditions. The static tests employed survey points as a baseline. The dynamic tests incorporated terminal area flight profiles and nonprecision approaches using a laser tracker as a base line. The accuracy performance of DGPS showed an order of magnitude improvement in the static environment and a 4 to 5 fold improvement in the dynamic environment over stand alone GPS. The DGPS tests were conducted in an effort to build an FAA DGPS data base to aid in addressing GPS questions/problems. GRA

N91-23150# Honeywell, Inc., Minneapolis, MN. Systems and Research Center.
NAVIGATION, GUIDANCE, AND TRAJECTORY OPTIMIZATION FOR HYPERSONIC VEHICLES
R. L. SCHULTZ, M. J. HOFFMAN, A. M. CASE, and S. I. SHEIKH *In* AGARD, Hypersonic Combined Cycle Propulsion 22 p Dec. 1990 Sponsored in part by AF
Copyright Avail: NTIS HC/MF A20; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

A computationally efficient, real time trajectory optimization and guidance approach for hypersonic aircraft is described. The optimization algorithms compute, in-flight, minimum fuel trajectories within constraints from the current aircraft position to its final destination. In-flight trajectory computation can provide a high degree of vehicle autonomy which could greatly reduce aircraft ground support costs. The optimization approach is based on Euler-Lagrange theory and energy state approximations. A 3-D, spherical earth, aircraft motion model, with constraints on temperature, dynamic pressure and stall, is used. An exact optimal iterative solution and an approx. closed form feedback solution method are developed. In the exact approach, solutions are computed by iteration on adjoint constants. Each iteration requires a complete forward trajectory integration. In the approx. closed form feedback approach, the adjoint constants are expressed in terms of the states. No forward trajectory calculations are required, thus, the computations are minimal. Minimum fuel climb to orbit, powered abort, and unpowered abort trajectories are computed with both methods. The approx. closed form feedback solution closely matches the optimal iterative solution. A computationally efficient method for generating unpowered descent footprints is also described. Footprints are used to identify candidate landing sites under an engine failure or other emergency conditions, and to initiate final descent. A hypersonic vehicle guidance, navigation, and control configuration using the optimal closed form feedback guidance and the footprint generator is described. Author

N91-24189# Federal Aviation Administration, Washington, DC.
AVIATION SYSTEM CAPITAL INVESTMENT PLAN Annual Report
Dec. 1990 355 p
(PB91-150268) Avail: NTIS HC/MF A16 CSCL 17/7

The plan describes the policies and strategies that the FAA will pursue in addressing key concerns of the National Airspace System (NAS). The plan addresses safety, efficiency, traffic demands, aging equipment and facilities, and airspace use. The Capital Investment Plan (CIP) was developed to prepare the NAS for new developments. The plan makes the approach to air traffic modernization more precise, flexible, understandable, and dynamic. It distinguishes among near-term (1991-1995), mid-term (1996-2000), and far-term (2001-2005) planning. GRA

N91-24190# Federal Aviation Administration, Atlantic City, NJ.
MLS MATHEMATICAL MODEL VALIDATION STUDY USING AIRBORNE MLS DATA FROM ATLANTIC CITY INTERNATIONAL AIRPORT BOEING 727 ELEVATION SHADOWING FLIGHT TESTS Technical Report, Dec. 1988 - Dec. 1990
JESSE D. JONES Apr. 1991 49 p
(DOT-FAA/CT-TN90/55) Avail: NTIS HC/MF A03

The performance of the Microwave Landing System (MLS) mathematical model is evaluated by comparing the results of the model's simulation errors along a flight path with actual flight check measurements. The data collected for this study were designed specifically to evaluate the shadowing aircraft computations of the model. The results showed that there was some agreement between measured and modeled data, but it was concluded that further development of the shadowing aircraft computations is required. Author

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A91-36354#
A320 - FIRST OF THE COMPUTER-AGE AIRCRAFT
DIDIER PUYPLAT (Airbus Industrie, Blagnac, France) Aerospace America (ISSN 0740-722X), vol. 29, May 1991, p. 28-30.
Copyright

The development of the A320 fly-by-wire primary controls that drive the aircraft's ailerons and elevator and the secondary controls that drive the flaps, slats, and spoilers on the wing are described. FBW controls practically eliminate the mechanical arrangement of cable-run controls that drive up airframe weight and maintenance costs and keep pilots within the speed and maneuver limitations of the aircraft's flight envelope. Introduction and development of the sidestick controller that provides an electrical input to the FBW computers, replacing the traditional control column, are discussed. A centralized fault display system that automatically records any in-flight problems and can be used to interrogate and test the aircraft's systems is also described. R.E.P.

A91-36357
ROTOR-FUSELAGE DYNAMICS OF HELICOPTER AIR AND GROUND RESONANCE
ROBERT A. ORMISTON (U.S. Army, Aeroflightdynamics Directorate, Moffett Field, CA) American Helicopter Society, Journal (ISSN 0002-8711), vol. 36, April 1991, p. 3-20. refs
Copyright

An analytical investigation of the air- and ground-resonance characteristics of simplified hingeless-rotor helicopter configurations was undertaken. The objectives were to identify and interpret the unique characteristics of coupled rotor-body modes that determine air-resonance stability characteristics, as contrasted to ground-resonance phenomena. The study examined the influence on air-resonance stability of unusual rotor-body modal characteristics such as nonoscillatory body modes. The results indicate that air-resonance instability does not require distinct coalescences of lead-lag and rotor-body modal frequencies, and unusual rotor-body frequency characteristics do not significantly alter the occurrence of air-resonance instability or the effectiveness of aero-elastic couplings. The character of air-resonance and flap-lag instabilities was found to change significantly at high rotor speeds for high-Lock number and low-inertia configurations. It was found that the rotor-body modes that participate in both air and ground resonance can be related to one another. Author

A91-36360
GROUND RESONANCE OF A HELICOPTER WITH INTER-CONNECTED BLADES
A. ROSEN (Technion - Israel Institute of Technology, Haifa) and N. M. SELA American Helicopter Society, Journal (ISSN 0002-8711), vol. 36, April 1991, p. 82-85. refs
Copyright

The ground resonance problem of a helicopter with a rotor incorporating interconnected blades is analyzed. The blades are interconnected with springs and dampers. In analyzing such a problem, terms not found in rotors without interblade coupling are encountered. The classic Multiblade Coordinate Transformation cannot deal with these terms, and a Modified Multiblade Coordinate Transformation is derived. The set of constant coefficient equations is obtained, using the modified transformation. Examination of the equations reveals that the interconnecting springs and dampers are more effective than blade-to-hub springs and dampers, for most existing rotors. Author

A91-36940
THE DESIGN, MANUFACTURE, AND TEST OF A ONE-PIECE THERMOPLASTIC WING RIB FOR TILTROTOR AIRCRAFT
E. J. SHAHWAN (Bell Helicopter Textron, Inc., Fort Worth, TX) Society of Manufacturing Engineers, Conference on Fabricating Composites '90, Arlington, TX, Oct. 8-11, 1990. 22 p.
(SME PAPER EM90-665) Copyright

Existing tiltrotor aircraft wing ribs, fabricated from carbon/epoxy thermoset materials, use five stiffeners and two cords attached to the rib web by approximately 150 mechanical fasteners. This program aims to reduce aircraft weight and cost by designing a one-piece thermoplastic wing rib. Full-scale thermoplastic ribs are made using various processes, then structurally tested to validate the design concept. To reduce weight and cost, a cost-sharing program was implemented between Bell Helicopter Textron, Incorporated and four major thermoplastic fabricators; this consists of designing, fabricating, and testing a thermoplastic wing rib. This paper addresses design concept, material characterization, proposed tooling and manufacturing approach, structural testing, and preliminary cost and weight savings to support program objectives. Author

A91-36942
SPOT WELDED THERMOPLASTIC COMPOSITE ACCESS DOOR
J. SCHWARZ and M. SANDNES (Lockheed Aeronautical Systems Co., Burbank, CA) Society of Manufacturing Engineers, Conference on Composites in Manufacturing 9, San Diego, CA, Jan. 15-18, 1990. 9 p.
(SME PAPER EM90-489) Copyright

This paper describes the design philosophy, and design details, structural tests, (including static and fatigue of ultrasonic spot-welds), and final manufacture and assembly of lower engine access doors. Two doors were installed on operational aircraft for an extended flight evaluation. A third door was fabricated for testing to verify the structural design with process characteristics.
Author

A91-37050
TOWARD ENHANCED FIGHTER COMBAT EFFECTIVENESS
Aerospace Engineering (ISSN 0736-2536), vol. 11, May 1991, p. 8-12.
Copyright

A continuing USAF development program concentrates on integrating and demonstrating critical technologies that will improve fighter aircraft survivability during air combat engagements. Emphasis of the Integrated Control and Avionics for Air Superiority (ICAAS) program is centered on beyond-visual-range multiple target attack capability, with provisions for effective transition to close-in combat. ICAAS development is divided into five primary functions: tactics, attack management, attack guidance, defensive assets manager, and performance monitor. Each of these functions is discussed along with total system integration. A specific ICAAS approach has been developed, and the software/hardware components have been incorporated into the system. R.E.P.

A91-38127
COMMERCIAL AIRCRAFT FUEL EFFICIENCY POTENTIAL THROUGH 2010
DAVID L. GREENE (Oak Ridge National Laboratory, TN) IN: IECEC-90; Proceedings of the 25th Intersociety Energy Conversion Engineering Conference, Reno, NV, Aug. 12-17, 1990. Vol. 4. New York, American Institute of Chemical Engineers, 1990, p. 106-111. Previously announced in STAR as N91-12671. refs
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Aircraft are second only to motor vehicles in the use of motor fuels, and air travel is growing twice as fast. Since 1970 air travel has more than tripled, but the growth of fuel use has been restrained by a near doubling of efficiency, from 26.2 seat miles per gallon (SMPG) in 1970 to about 49 SMPG in 1989. This paper explores the potential for future efficiency improvements via the replacement of existing aircraft with '1990's generation' and 'post 2000' aircraft incorporating advances in engine and

airframe technology. Today, new commercial passenger aircraft deliver 50 to 70 SMPG. New aircraft types scheduled for delivery in the early 1990's are expected to achieve 65 to 80 SMPG. Industry and government researchers have identified technologies capable of boosting aircraft efficiencies to the 100 to 150 SMPG range. Under current industry plans, which do not include a post-2000 generation of new aircraft, the total aircraft fleet should reach the vicinity of 65 SMPG by 2010. A new generation of 100 to 150 SMPG aircraft introduced in 2005 could raise the fleet average efficiency to 75 to 80 SMPG in 2010. In any case, fuel use will likely continue to grow at from 1 to 2 percent per yr. through 2010. Author

A91-38548*# Continuum Dynamics, Inc., Princeton, NJ.
OPTIMIZATION OF ROTOR PERFORMANCE IN HOVER USING A FREE WAKE ANALYSIS
T. R. QUACKENBUSH, D. A. WACHSPRESS, and A. E. KAUFMAN (Continuum Dynamics, Inc., Princeton, NJ) Journal of Aircraft (ISSN 0021-8669), vol. 28, March 1991, p. 200-207. Previously cited in issue 11, p. 1610, Accession no. A90-28175. refs
(Contract NAS2-12789)
Copyright

A91-38549#
FULL-SCALE DEMONSTRATION TESTS OF CABIN NOISE REDUCTION USING ACTIVE VIBRATION CONTROL
M. A. SIMPSON, T. M. LUONG (Douglas Aircraft Co., Long Beach, CA), C. R. FULLER (Virginia Polytechnic Institute and State University, Blacksburg), and J. D. JONES (Purdue University, West Lafayette, IN) Journal of Aircraft (ISSN 0021-8669), vol. 28, March 1991, p. 208-215. Previously cited in issue 13, p. 1943, Accession no. A89-33719.
Copyright

A91-38550*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AIRFOIL DESIGN METHOD USING THE NAVIER-STOKES EQUATIONS
J. B. MALONE (NASA, Langley Research Center, Hampton, VA), J. C. NARRAMORE (Bell Helicopter Textron, Inc., Fort Worth, TX), and L. N. SANKAR (Georgia Institute of Technology, Atlanta) Journal of Aircraft (ISSN 0021-8669), vol. 28, March 1991, p. 216-224. Research supported by Bell Helicopter Textron, Inc. and U.S. Army. Previously announced in STAR as N90-20981. refs
Copyright

An airfoil design procedure is described that was incorporated into an existing 2-D Navier-Stokes airfoil analysis method. The resulting design method, an iterative procedure based on a residual-correction algorithm, permits the automated design of airfoil sections with prescribed surface pressure distributions. The inverse design method and the technique used to specify target pressure distributions are described. It presents several example problems to demonstrate application of the design procedure. It shows that this inverse design method develops useful airfoil configurations with a reasonable expenditure of computer resources. Author

A91-38752
DESIGNING WITH COMPOSITES - A STUDY OF DESIGN PROCESS
S. R. SHANKAR, A. SHARKAWY, C. P. BURGER, and D. G. JANSSON (Texas A & M University, College Station) IN: Composite material technology 1990; Proceedings of the Symposium, 13th ASME Annual Energy-Sources Technology Conference and Exhibition, New Orleans, LA, Jan. 14-18, 1990. New York, American Society of Mechanical Engineers, 1990, p. 1-6. refs
Copyright

Utilizing a detailed examination of the numerous design decisions in the design of a complex composite aircraft part, it is shown that the dependence of the design process on manufacturing issues is uniquely strong in the design of composite parts and assemblies. Although this dependence is true for design in general, it is amplified by the high degree of coupling between functional and production requirements which characterize the utilization of composite materials. The findings presented in this paper point to a methodology for designing with composites. Furthermore, a model for study of other design activity is suggested by the useful insights developed by this approach. Author

A91-39377
DEMONSTRATION OF A LASER ORDNANCE INITIATION SYSTEM IN AN F-16 SLED
JOHN A. COBBETT and MURPHY J. LANDRY (Scot, Inc., Downers Grove, IL) IN: Annual SAFE Symposium, 27th, New Orleans, LA, Dec. 5-8, 1989, Proceedings. Newhall, CA, SAFE Association, 1990, p. 1-3.
Copyright

A feasibility study demonstrating certain key aspects of the Laser Ordnance Initiation System is presently conducted. To demonstrate its potential for aircrew egress, a static F-16 sled at Holloman AFB is utilized. The Laser Ordnance Initiation System will jettison the canopy by an initial mechanical actuation of two pyrolasers. Laser energy produced by each pyrolaser is transmitted through a fiber-optic circuit to four different initiation points. At each initiation point, an existing ordnance device inherent to the F-16 is activated redundantly and the canopy is jettisoned. Prior to this demonstration, breadboard tests were conducted utilizing electrical, high-pressure gas, and mechanically actuated pyrolasers in a test setup similar to the sled. Author

A91-39380
DEVELOPMENT AND DEMONSTRATION OF CREST SUBSYSTEMS
D. E. SWANSON (Boeing Military Airplanes, Seattle, WA) IN: Annual SAFE Symposium, 27th, New Orleans, LA, Dec. 5-8, 1989, Proceedings. Newhall, CA, SAFE Association, 1990, p. 14-18.
Copyright

The designs and tests for each of the major CREST program subsystems are described. The subsystems include a graphite epoxy seat structure, controllable thrust catapult, windblast protection system capable of protection up to 700 KEAS, and an avionics system that includes advanced sensors and high-speed microprocessors. Results from structural proof load tests, windblast tests, wind tunnel tests, seat/man separation tests, and catapult dynamic tests are presented. The adaptive performance of components for an advanced ejection seat including windblast protection, adaptive restaint, digital flight control, and advanced sensors was demonstrated. The findings provide the engineering data required to proceed to full-scale ejection tests during the next phase of the CREST program. P.D.

A91-39382
FIGHTER ESCAPE SYSTEM - THE NEXT STEP FORWARD
BRIAN A. MILLER (Martin-Baker Aircraft Co., Ltd., Higher Denham, England) IN: Annual SAFE Symposium, 27th, New Orleans, LA, Dec. 5-8, 1989, Proceedings. Newhall, CA, SAFE Association, 1990, p. 53-57. Previously announced in STAR as N90-20059.
Copyright

Ejection seats have become increasingly complex, heavier and bulkier in recent years. This growth in response to the increasing demands for greater performance, under more severe conditions. It is also due to the relocation onto the seat of equipment which was previously aircraft mounted such as anti-g valve, oxygen regulator, NBC equipment, and OBOGS auxiliary oxygen equipment. In the Tornado, the Mk10A ejection seat even gained outlets for the cabin conditioning system, becoming the world's first air conditioned ejection seat. This trend has persisted for some 15 years, but now new design derivers are becoming dominant with an increasing and urgent need for lightweight and low cost. The Martin-Baker developments of the past 15 years are briefly reviewed and the new trends which are shaping future Fighter Escape Systems discussed. Author

A91-39385
EJECTION SEAT ROCKET CATAPULT DESIGN FOR REDUCED G FIELD INFLUENCE

CRAIG WHEELER and FRANK COSTIGAN (U.S. Navy, Naval Ordnance Station, Indian Head, MD) IN: Annual SAFE Symposium, 27th, New Orleans, LA, Dec. 5-8, 1989, Proceedings. Newhall, CA, SAFE Association, 1990, p. 108-113.
Copyright

Modern aircraft with high G maneuverability require an aircrew ejection seat that can perform under high G-loads. Analytical methods were used to study design methods that could decrease the influence of high G on catapult performance. Computer simulations of an existing catapult and theoretical designs were performed. The computer program's accuracy was validated by comparing the results to static firings at normal and high Gs. Simulations were performed at various G loads, temperatures, and seat weights. The study showed that the propellant burning rate exponent contributed significantly towards the sensitivity of the catapult performance at high impressed Gs. Low-pressure catapult designs provide advantages over high-pressure designs by permitting the use of a low exponent propellant burning rate that reduces temperature and G-field sensitivity. Author

A91-39390
THE MINIPAC II EJECTION SEAT PROGRAM
ROBERT B. CALKINS (McDonnell Douglas Corp., Long Beach, CA) IN: Annual SAFE Symposium, 27th, New Orleans, LA, Dec. 5-8, 1989, Proceedings. Newhall, CA, SAFE Association, 1990, p. 160-163.
Copyright

The Minipac II ejection seat was developed to provide a lightweight, compact, and inexpensive ejection seat for smaller, low-speed aircraft such as turbo trainers and helicopters. This paper describes the design and performance of the Minipac II seat. By limiting the maximum speed to 380 keas, performance close to that of ACES II was achieved without resorting to expensive sequencing. The seat envelope is from zero altitude-zero speed to 380 keas at 50,000 feet. High aft visibility and long scheduled maintenance intervals are the features. Manual over-the-side bailout is an option that is still available. Author

A91-39394
HARDWARE-IN-THE-LOOP TESTING OF THE CREST EJECTION SEAT CONTROL SYSTEM
G. J. BURMEISTER and B. M. FRITCHMAN (Boeing Co., Advanced Systems Div., Seattle, WA) IN: Annual SAFE Symposium, 27th, New Orleans, LA, Dec. 5-8, 1989, Proceedings. Newhall, CA, SAFE Association, 1990, p. 181-186.
Copyright

The purpose of the Crew Escape Technologies (CREST) program is to demonstrate new technologies for ejection seats. These seats must be capable of meeting new expanded escape envelope requirements being established by the high-performance capabilities of existing and planned fighter aircraft. These requirements include active attitude and trajectory control of the ejection seat, catapult-acceleration control, propulsion-acceleration control, wind-blast protection, adaptive pilot restraints, and the parachute-deployment attitude and timing. Control system software for control of the CREST ejection seat was written during the current phase IIB of the CREST contract. This software will be used in phase III sled track tests at Holloman Air Force Base. Author

A91-39395
NORTHROP ADVANCED FIGHTER CREW PROTECTION SYSTEM. I - ENGINEERING DEVELOPMENT. II - SYSTEM DEVELOPMENT, TEST AND EVALUATION
JOHN DAMRON (ILC Dover, Frederica, DE) and SAM PUMA (Northrop Corp., Aircraft Div., Hawthorne, CA) IN: Annual SAFE Symposium, 27th, New Orleans, LA, Dec. 5-8, 1989, Proceedings. Newhall, CA, SAFE Association, 1990, p. 187-194.
Copyright

The present paper describes the development of an advanced fighter crew protection system, an integrated crew system that protects from hostile environments (altitude, acceleration, ejection, thermal, chemical, biological, nuclear, directed radiation, and munitions) while enhancing mission performance. Descriptions of the following system components are provided: suit assembly, helmet assembly, partial pressure suit, composite assembly, microclimate conditioning subsystem, portable ventilation system, and also portable test equipment. Preliminary results are reported from tests conducted to prove the concept: windblast, explosive atmosphere, heat load, chemical agent simulant, centrifuge, altitude chamber, cockpit compatibility, water immersion, and flight test. P.D.

A91-39398
CANOPY BREAKING SYSTEM FOR NON-DELAY PILOT RESCUE
RALPH KOCH (Dornier GmbH, Friedrichshafen, Federal Republic of Germany) and HARTMUT GEHSE (Dornier Luftfahrt GmbH, Friedrichshafen, Federal Republic of Germany) IN: Annual SAFE Symposium, 27th, New Orleans, LA, Dec. 5-8, 1989, Proceedings. Newhall, CA, SAFE Association, 1990, p. 207-210.
Copyright

Technology for the accelerated rescue of a pilot from his cockpit is discussed. Consideration is given to the development of a new canopy-breaking system which does not impair the pilot's view and offers the following advantages: rescue time in uncontrollable aircraft is shortened; bird strike risk is reduced; splintered glass is avoided when the canopy is fragilized and opened and fractured glass is removed from the pilots' ejection path in a defined way; and the ejection path is immediately opened while an optimally controlled transparency structure is maintained. Schemes illustrate the trial and future setup of cutting-cord installation; calculated stress curves for two critical points and crack formation observed during testing; the position and time dependence of calculated stress lines within the transparency half; and the cutting cord arrangement. P.D.

A91-39420#
APPLICATION OF MULTIPLE-INPUT/SINGLE-OUTPUT ANALYSIS PROCEDURES TO FLIGHT TEST DATA
J. K. SRIDHAR (National Aeronautical Laboratory, Bangalore, India) and G. WULFF (DLR, Institut fuer Flugmechanik, Brunswick, Federal Republic of Germany) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, May-June 1991, p. 645-651. refs
Copyright

A computer program for the analysis of correlated multiple-input/single-output systems has been developed using the techniques of Bendat. This iterative procedure allows spectral separation to enable sequential as well as combined inspection of input/output relationships. The analogy of conditioning of spectral density functions to that of Gaussian elimination has been used for efficient realization of the algorithm. Described are the method and its applications to flight test data of two research vehicles, a helicopter and a new in-flight simulator. The examples show the detection of extraneous noise at the output caused by a fewer number of inputs together with the investigation of the control buildup in the helicopter case, and in the other case the influence of the autotrim system of the in-flight simulator on its direct lift control flaps. The results and conclusions are drawn based on the investigation of spectra and coherence functions. Author

A91-40156#
AIR SURVEYING AND DATA ANALYSIS FOR DYNAMIC RESPONSE OF MISSILES AT SWEPT-BACK WING TIP
ZEMIN HUANG (Shenyang Aircraft Corp., People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 11, Nov. 1990, p. A565-A569. In Chinese, with abstract in English.

The dynamic response of missiles mounted at the tip of a swept-back aircraft wing to typical loads is measured in flight tests at altitudes 600-10,100 m and velocities up to 1080 km/h. The data are presented in tables and briefly characterized. Conditions examined include wake effects, gusts, unsteady flow, landing collision, high speed at low altitude, overloading, acrobatic maneuver, and high-Mach-number level flight. D.G.

A91-40158#
THE NONLINEAR DYNAMIC RESPONSE ANALYSIS OF THE FRONT WINDSHIELD OF Y12 UNDER 'BIRD-IMPACT' LOADS
JIAN WEN (Aircraft Structure Strength Research Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 11, Nov. 1990, p. A573-A577. In Chinese, with abstract in English.

The finite element analysis program system VEP is used to carry out the numerical analysis of nonlinear dynamic response of the aircraft Y12's front windshield at three points B, C, and D under bird impact condition. The weight of the bird is 0.91 kg, and the velocity is 56-61 m/s. The calculated results are compared with the experimental results; it is found that the results are in good agreement except at the point D. Author

A91-40160#
APPLICATION OF ACOUSTICALLY TREATED HONEYCOMB SANDWICH PANELS IN NOISE CONTROL OF AIRCRAFT CABIN
WENCHAO HUANG (Aircraft Structure Strength Research Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 11, Nov. 1990, p. A584-A588. In Chinese, with abstract in English.

The acoustic treatment of honeycomb sandwich panels to reduce low-frequency cabin noise in propeller aircraft cabins is described. The theoretical basis of the treatment method is discussed, and results from transmission-loss measurements on treated and untreated sidewall panels at 63-8000 Hz are presented in graphs. The effectiveness of the treatment is demonstrated. D.G.

A91-40161#
NUMERICAL ANALYSIS OF SOLID-FUEL INTERACTIVE VIBRATION ON AN AIRCRAFT INTEGRAL TANK
ZHISHANG MAO and JUEMIN YANG (Nanchang Aircraft Manufacturing Co., People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 11, Nov. 1990, p. A589-A594. In Chinese, with abstract in English. refs

The vibration induced in an aircraft tank by solid-fuel interactions is studied by means of numerical calculations, applying an extended pseudoelastic method in combination with a generalized FEM software package. A complex geometry of C-shaped cross section is considered, and the results are compared with published experimental data in graphs. Procedures are developed to detect and eliminate spurious frequencies which arise due to discretization errors. D.G.

A91-40162#
CALCULATION AND EXPERIMENTAL STUDY ON SONIC FATIGUE LIFE OF AIRCRAFT STRUCTURAL PANELS
SEN GE and ZHILUN ZHOU (Aircraft Structure Strength Research Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 11, Nov. 1990, p. A595-A598. In Chinese, with abstract in English.

The response of 1.2-mm-thick rectangular Al-alloy panels to acoustic fatigue loading at 149-163 dB and 109 Hz is measured experimentally. The experimental setup and procedures are described; the data are presented in tables and graphs; and a detailed comparison is made with the results of calculations using the so-called DSR method. D.G.

A91-40165#
VIBRATION PROBLEMS IN AN AIRCRAFT DESIGN
RONGMING SHI (Shenyang Aircraft Research Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 11, Nov. 1990, p. A612-A614. In Chinese, with abstract in English.

A brief overview of the problems posed by vibration in experimental aircraft is given. The negative effects of vibrations are recalled; the technology of vibration suppression and control is discussed; and a step-by-step approach to the solution of vibration problems in the aircraft design and development process is outlined. D.G.

A91-40170#
IDENTIFICATION OF NACELLE MODES FROM AIRPLANE GVT RESULTS
FENGSHAN WANG (Aircraft Structure Strength Research Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 11, Nov. 1990, p. A630-A636. In Chinese, with abstract in English.

An algorithm for identifying nacelle vibrational modes on the basis of data from ground vibration tests (GVTs) is developed and demonstrated. The derivation is given in detail; a flow chart is shown; and results obtained using typical GVT data are presented in tables. D.G.

A91-40171#
A STUDY ON SONIC LOAD OF THE VERTICAL TAIL OF F-7 AIRCRAFT
XUEZHEN NING (Chengdu Aircraft Co., People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 11, Nov. 1990, p. A637-A640. In Chinese, with abstract in English.

Results are reported from ground and flight acoustic loading tests on the vertical tail structure of the Chinese F-7 fighter aircraft. The data are presented in tables and briefly characterized. It is shown that the acoustic pressures obtained on the ground can be substituted for the flight-test values as long as the sensors are placed 5 cm or less from the tail surface. D.G.

A91-40172#
FLEXURE VIBRATION TEST METHOD OF AVIATION TUBE
XU CHEN and JIN LIU (Xian Aircraft Industry Co., People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 11, Nov. 1990, p. A641-A643. In Chinese, with abstract in English. refs

Two standard procedures for flexural-vibration testing of aircraft hydraulic tubing are discussed: ISO TC 20/SC 10 N836 and N925 (1985) and U.S. MIL-F 18280D and 18280E supplements (1983 and 1986). The crucial importance of tubing reliability is emphasized, and particular attention is given to cantilever-beam vs simple-beam testing, specimen length estimation, the transformation of static strain to oil-pressure-induced stress, strain or stress control, measurement errors related to specimen diameter, and errors due to strain-gage size and position. D.G.

A91-40174#
A NUMERICAL METHOD FOR SIMULATING DROP TEST OF LANDING GEARS
XUEREN NI (Xian Aircraft Co., People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 11, Nov. 1990, p. A647-A649. In Chinese, with abstract in English.

The theoretical basis and implementation of an algorithm for estimating the discharge coefficient of an aircraft landing gear without the need for conventional drop testing are described. The derivation of the method is outlined, and typical results are presented in graphs. The usefulness of the method in the aircraft design phase is also indicated. D.G.

A91-40203
LANDING GEAR DROP TESTING
Aerospace Engineering (ISSN 0736-2536), vol. 11, June 1991, p. 42-44.
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Preliminary research has indicated that applying active-control technology to the landing gears could reduce ground loads applied to the airframe. Utilizing the drop test apparatus, researchers dropped the nose gear vertically with lift at 1.37 m/s in both active and passive modes. A 1-g lift simulation was obtained by employing crushable aluminum honeycomb to stop the drop carriage (upper mass) vertical acceleration. It is concluded that based on the drop tests, the concept derived can reduce significantly the loads transmitted by the gear to the airframe during landing and ground operations. R.E.P.

A91-40254#
COMANCHE - TOMORROW'S HIGH-TECH HELICOPTER
STEVEN ASHLEY Mechanical Engineering (ISSN 0025-6501), vol. 113, June 1991, p. 40-45.
Copyright

The RAH-66 Comanche helicopter for whose production the U.S. Army has recently signed a $34 billion contract is a two-crewmember armed scout helicopter, comparable in weight to the AH-1 Cobra helicopter gunship, whose armaments are primarily oriented to the destruction of ground forces. Air-to-air capabilities are also an intrinsic element of the design, making this the first U.S. rotary wing aircraft thus equipped. Unique features of the Comanche include a damage-resistant all-composite airframe, a maneuverable optimized fan-in-fin tail rotor system, and cockpit volumes that are pressurized for protection against chemical and biological warfare. Retractable weapons carriage and landing gear systems enhance stealth performance. Power is furnished by two 1200-shp T800 turboshaft engines. O.C.

A91-40495
EFFECTS OF CANARD POSITION ON THE AERODYNAMIC CHARACTERISTICS OF A CLOSE-COUPLED CANARD CONFIGURATION AT LOW SPEED
D. HUMMEL (Braunschweig, Technische Universitaet, Brunswick, Federal Republic of Germany) and H.-CHR. OELKER (Dornier Luftfahrt GmbH, Friedrichshafen, Federal Republic of Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X), vol. 15, no. 2, 1991, p. 74-88. Previously announced in STAR as N90-28519. refs
(Contract DFG-HU-254/8)
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Comprehensive wing-tunnel investigations were carried out on a close-coupled A = 2.31 delta-canard configuration at low speed. Based on three-component, surface pressure, and flowfield measurements as well as on oilflow patterns, the flow about the coplanar normal configuration may be regarded as well understood. Three parameters describing the position of the canard relative to the wing were varied systematically within certain limits: vertical distance (3 locations: high, coplanar, low), longitudinal distance (3 locations: front, mid, rear), and canard setting angle (-12 deg is less than or equal to epsilon is less than or equal to 12 deg). The results of three-component measurements are presented and the corresponding flow structure is analyzed by means of pressure distribution measurements and oilflow patterns. For a large variety of parameter combinations in the vicinity of the normal configuration the same state of the flow with two separate vortex systems for canard and wing was found, and the effects of different canard positions relative to the wing on the aerodynamic coefficients could be explained by this mechanism. For low canard positions and large setting angles, however, the formation of vortices on the lower surface of the wing as well as the merging of the canard vortices with the wing vortex system on the upper surface was observed. This flow structure leads to abrupt changes in the aerodynamic coefficients which are unacceptable for practical flight conditions. Author

A91-40501
VECTORED PROPULSION, SUPERMANEUVERABILITY AND ROBOT AIRCRAFT
BENJAMIN GAL-OR (Technion - Israel Institute of Technology, Haifa) Research sponsored by Teledyne CAE, General Electric Co., USAF, and General Dynamics Corp. New York, Springer-Verlag, 1990, 276 p. refs
Copyright

The emergence of digital flight control/engine control systems affords airframe and propulsion system designers opportunities for much higher degrees of integration between propulsion and aerodynamics, yielding revolutionary levels of performance. The present work offers a comprehensive consideration of these possibilities in the case of vectorable-thrust propulsion systems in which aircraft agility is enhanced by multiaxis thrust vectoring and reaction-control; attention is given to the application of such systems to not only piloted, but also remotely piloted and robotic aircraft. The consequences of external and internal (nozzle-integral) methods of thrust vectoring are discussed. O.C.

A91-40511
AIRCRAFT PERFORMANCE
DONALD LAYTON (U.S. Naval Postgraduate School, Monterey, CA) Chesterland, OH, Weber Systems, Inc., 1988, 234 p. refs
Copyright

A comprehensive introduction to the factors determining the performance of subsonic fixed-wing aircraft is presented, ranging over atmospheric conditions, drag and thrust characteristics, climb performance, range and endurance criteria, maneuvering characteristics, and takeoff and landing behavior. Attention is given to airspeed instrumentation, the induced drag and profile drag components of total drag, altitude effects on aircraft performance, reciprocating and turbine engine propulsion system effects on performance, and the determinants of climb rate for a given aircraft. Also treated is the effect of weight on turbine and propeller aircraft ranges, the parameters affecting takeoff and landing performance, and the most frequently used tests of aircraft performance. O.C.

N91-23107# Israel Aircraft Industries Ltd., Ben-Gurion Airport. Engineering Div.
REAL TIME ESTIMATION OF AIRCRAFT ANGULAR ATTITUDE
G. SHADMON Apr. 1987 16 p
(IAITIC-87-1004; ITN-88-85003) Avail: NTIS HC/MF A03

A new method is presented for estimating aircraft angular attitude under real time conditions. The basis for the estimation is the requirement of best possible compatibility between the current estimate and the time history of the past measurements. The characteristics of the estimation technique are: (1) use of the quaternion formalism on characterizing the rotational motion; (2) adoption of the Least Square (LS) method as the tool of extracting the estimated quaternion out of the foregoing requirement; and (3) incorporation of the fading memory technique as a means of reducing the sensitivity to modelling errors. The main advantage of that method is its extremely small computation burden. This is reflected by a lack of the usual operations of matrix inversion and matrix propagation in time. Included are the review of the pertinent quaternion properties, the derivation of the estimation method, and the application to a real case. ISA

N91-23108# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Flight Mechanics Panel.
FLYING QUALITIES
Feb. 1991 379 p In ENGLISH and FRENCH Symposium held in Quebec City, Quebec, 15-18 Oct. 1990
(AGARD-CP-508; ISBN-92-835-0602-2) Copyright Avail: NTIS HC/MF A17; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The purpose of this symposium was to review flying quality issues of today and to report progress towards their resolution. The following topic areas were covered: (1) flying qualities experiences and contemporary aircraft; (2) application of flying qualities specifications; (3) flying qualities research; and (4) flying qualities at high incidence.

N91-23109# Thomas (Dieter), Fuerstenfeldbruck (Germany, F.R.).
THE ART OF FLYING QUALITIES TESTING
DIETER THOMAS *In* AGARD, Flying Qualities 12 p Feb. 1991
Copyright Avail: NTIS HC/MF A17; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

A veteran test pilot discusses the need for flight test engineers to listen to test pilot opinion in designing cockpits and flight control systems. Through personal experiences, the test pilot illustrates the practical evaluation of good flying qualities and techniqes used in this evaluation for the promotion of air safety through the expression of pilot opinion. K.S.

N91-23110# McDonnell-Douglas Helicopter Co., Mesa, AZ.
ADFCS AND NOTAR (TRADEMARK): TWO WAYS TO FIX FLYING QUALITIES
CHANNING S. MORSE *In* AGARD, Flying Qualities 13 p Feb. 1991
Copyright Avail: NTIS HC/MF A17; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The development, flight tests, and flying qualities of the Advanced Digital Flight Control System (ADFCS) and No Tail Rotor (NOTAR) System for military helicopters are reviewed. Emphasis is placed on some of the directional control problems faced on the ADFCS program in left sideward flight and the potential for the NOTAR system to improve the flying qualities of an advanced, highly augmented rotorcraft. Author

N91-23111# Air Force Flight Dynamics Lab., Wright-Patterson AFB, OH.
MIL-STD-1797 IS NOT A COOKBOOK
DAVID B. LEGGETT and G. THOMAS BLACK (Aeronautical Systems Div., Wright-Patterson AFB, OH.) *In* AGARD, Flying Qualities 19 p Feb. 1991
Copyright Avail: NTIS HC/MF A17; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Despite many years of experience, some confusion still exists concerning the nature, purpose, and application of the flying qualities specifications. Much of this confusion stems from the form of the requirements themselves. A question frequently raised is whether flying qualities are pilot-oriented properties or whether they are the parameters defined in the requirements of the flying qualities specification. This question arises from the fact that most of the objective criteria in the specification are not closed-loop (pilot-in-the-loop) performance criteria or pilot acceptance criteria, but rather are criteria on open-loop (pilot-out-of-the loop) characteristics of the augmented aircraft. Another source of confusion concerns the role of the specification itself: is it only a contractual document, or is it also a design guide. If the latter, is it equally effective in both roles. Consideration of the above questions leads to yet another. If the specification is intended as a design guide and the criteria are open-loop properties instead of closed-loop properties, which is more important: pilot satisfaction with closed-loop performance or compliance with the open-loop requirements? These questions are addressed by reviewing the background of the United States military flying qualities specifications. The advantages and disadvantages of different types of requirements are discussed. The way the specification is used by the USAF Aeronautical Systems Division Program offices is described. Author

N91-23112# Aeritalia S.p.A., Turin (Italy). Flight Mechanics Group.
FLYING QUALITIES EXPERIENCE ON THE AMX AIRCRAFT
BAVA RENZO *In* AGARD, Flying Qualities 20 p Feb. 1991
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The AMX is a subsonic ground attack aircraft with a fly-by-wire flight control system (FCS) built into a digital flight control computer. From the flight mechanics point of view, it was designed against the MIL-F87985-C requirement. For some specific flight tasks, the need of more demanding requirements was envisaged. Modern handling qualities criteria were applied in the area of longitudinal and lateral-directional precision tracking task and pilot-induced oscillation (PIO) tendencies to cope with operational problems. High incidence criteria were used in the design and evaluation of control modifications which improve the flying qualities in the stall and post stall regions. Comparisons between analytical predictions, manned simulation, and in-flight results were made. Indications of agreement or disagreement with data and new criteria are presented. Author

N91-23115# Aeronautical Systems Div., Wright-Patterson AFB, OH.
DO CIVIL FLYING QUALITIES REQUIREMENTS ADDRESS MILITARY MISSIONS FOR OFF-THE-SHELF PROCUREMENT
G. THOMAS BLACK, WALTER A. GRADY (Test Wing, 4950th, Wright-Patterson AFB, OH), and DANN C. MCDONALD *In* AGARD, Flying Qualities 8 p Feb. 1991
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Off-the-shelf procurement of civil aircraft for use by the military services is a tradition dating back to the earliest days of aviation. This relieves the military of the responsibility for development costs, takes advantage of civil designs already in existence, and has resulted in the development of many capable military aircraft. However, while civil aircraft missions have remained relatively unchanged for over half a century, new military mission have continued to evolve. Yet, the military services still procure civil certified aircraft to accomplish these demanding missions. In the United States, Federal Aviation Regulations 23 and 25 and their predecessors are the certification standards for civil aircraft. The primary objective of these regulations is to insure a minimum standard of airworthiness. Flying qualities requirements make up only a small portion of these regulations, and address primarily static stability characteristics. This has sometimes led to undesirable flying qualities when attempting to perform demanding military mission with civil certificated aircraft. The unique military missions are addressed in the U. S. military flying qualities specification, MIL-STD-1797A, and its predecessors (MIL-F-8785 series). These military specification requirements are compared to the civil requirements to substantiate their applicability to off-the-shelf procurement. Specifically, where military and civil missions differ, military flying qualities requirements should be invoked. To illustrate this, several examples are examined. Finally, the future of off-the-shelf procurement is contemplated, some implications discussed, and recommendations made. Author

N91-23118# Pisa Univ. (Italy). Dipartimento di Ingregneria Aerospaziale.
METRICS FOR ROLL RESPONSE FLYING QUALITIES
MARIO INNOCENTI *In* AGARD, Flying Qualities 11 p Feb. 1991
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Roll characteristics of highly augmented aircraft during compensating tasks such as tracking and landing are shown to present degraded flying qualities and unstable oscillations similar to those observed in the pitch axis. The ideas behind Gibson's method are extended to develop handling qualities criteria for the roll axis control system. The analysis is performed using an existing data base for highly augmented class IV aircraft and parameters such as roll time constant, systems delay, and loop sensitivity are considered for designing for good handling qualities and to evaluate control systems performance. Levels of flying qualities are determined in the time domain as well as in the frequency domain for both tracking and landing tasks. The presence of pilot induced oscillations and roll ratcheting are identified. Author

N91-23120# Calspan Advanced Technology Center, Buffalo, NY. Flight Research Dept.
THE FLYING QUALITIES INFLUENCE OF DELAY IN THE FIGHTER PILOT'S CUING ENVIRONMENT
RANDALL E. BAILEY *In* AGARD, Flying Qualities 25 p Feb. 1991
(Contract F33615-83-C-3603)
Copyright Avail: NTIS HC/MF A17; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Flight testing has amply demonstrated the serious flying qualities deficiencies that can occur from excessive control system delay. Delay outside of the control system, yet within the pilot's cuing environment, can be potentially as deleterious as control system delay effects. Summarized here are the results of flight tests to evaluate the effect on flying qualities on time delay in the pilot's cuing environment introduced outside the flight control system. These delays were introduced in the tactile cuing, head-up display visual cuing, and the motion and visual cuing during the simulation of fighter aircraft. Author

N91-23122# National Aeronautical Establishment, Ottawa (Ontario). Flight Research Lab.
AN INITIAL STUDY INTO THE INFLUENCE OF CONTROL STICK CHARACTERISTICS ON THE HANDLING QUALITIES OF A FLY-BY-WIRE HELICOPTER
J. MURRAY MORGAN *In* AGARD, Flying Qualities 13 p Feb. 1991 Sponsored in part by Department of National Defence, Ottawa, Ontario
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A piloted experiment was flown using the Institute for Aerospace Research Bell 205A variable stability helicopter. The experimental variables were the static and dynamic characteristics of a conventional center-mounted cyclic controller. The cyclic controller characteristics were changed by varying the mass and spring gradient to provide five basic cases, while for each case the dynamics of the stick were varied to provide critically damped, underdamped, and overdamped models. Two pilots were asked to fly a variety of tasks designed to exercise three fundamental modes of helicopter flight, high frequency stabilization, gross single axis tasks with off axis stabilization and simultaneous multi axis control. The stick sensitivity was adjusted in proportion to the spring gradient to give constant static sensitivity with respect to applied force. A first order filter was incorporated on an optional basis to reduce the command response bandwidth of the roll channel to the Level 1/Level 2 boundary of the ADS-33C criterion for divided attention operation. The results achieved indicate that cyclic stick characteristics are of considerably less importance than had been previously thought, that large values of overdamping can be tolerated even in low frequency sticks, but that underdamped sticks should be avoided especially if the resonant frequency of the stick is close to an undesirable and easily excited aircraft mode. There was a suggestion that a boundary based on undamped natural frequency also existed. The results did not support the contention that inertia alone is enough to specify an acceptable/unacceptable boundary for stick design. Author

N91-23126# Test Squadron (6510th), Edwards AFB, CA.
B-1B HIGH AOA TESTING IN THE EVALUATION OF A STALL INHIBITOR SYSTEM
MARK S. SOBOTA *In* AGARD, Flying Qualities 21 p Feb. 1991
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High angle-of-attack (AOA) B-1B flight tests were conducted to evaluate a flight control Stall Inhibitor System/Stability Enhancement Function (SIS/SEF). The SIS/SEF system was integrated into the basic B-1B flight control system because of an inherent stability problem in the B-1 aircraft design. The problem lies in the fact that aerodynamically the B-1 was stability limited and not lift limited. This resulted in a lack of longitudinal stability while operating at high AOA conditions with no warning or natural cues to the pilot that the aircraft was approaching an unstable region. To safely utilize all the available AOA at the higher gross weights demanded, some means of providing 'apparent' stability was essential to provide cues to the pilot of these stability limitations. Significant test results of the SIS/SEF flight test program are presented. Author

N91-23127*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
FLYING QUALITIES OF THE X-29 FORWARD SWEPT WING AIRCRAFT
LAWRENCE A. WALCHLI (Wright Research Development Center, Wright-Patterson AFB, OH.) and ROGERS E. SMITH *In* AGARD, Flying Qualities 13 p Feb. 1991
Copyright Avail: NTIS HC/MF A17; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive
CSCL 01/3

An overview of the X-29 Forward Swept Wing Technology Demonstrator traces its development and test path during past years. Brief descriptions of the aircraft and its flight control system provide insight for evaluating this unique vehicle. The baseline flight control system provided a starting point for safe concept evaluation and envelope expansion for the aircraft. Subsequent up-dates resulted in performance levels favorably comparable to current fighter aircraft. Efforts are described for the current expansion of the X-29's capabilities into the high angle-of-attack (AOA) regime of flight. Control law changes have permitted all axis maneuvering to 40 deg AOA with pitch excursions to 66 deg, thereby exploiting the full potential of the X-29 forward swept wing configuration. Author

N91-23128# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.). Inst. fuer Flugmechanik.
HANDLING QUALITIES EVALUATION FOR HIGHLY AUGMENTED HELICOPTERS
HEINZ-JUERGEN PAUSDER and WOLFGANG VONGRUENHAGEN *In* AGARD, Flying Qualities 14 p Feb. 1991
Copyright Avail: NTIS HC/MF A17; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The realization and utilization of the helicopter airborne simulator ATTHeS (Advanced Technology Testing Helicopter System) are described. The explicit model following control system which is designed for ATTHeS is briefly presented. The potential is reviewed of the simulation system which is illustrated by the overall system performance identified from flight test data. Due to the implemented explicit model following systems, the in-flight simulation facility is provided with the capability of a flexible and broad variation of stability and control characteristics. Finally, results of a bandwidth phase delay study are presented and the influence of coupling on handling qualities evaluation is discussed. Author

N91-23129# Naval Air Development Center, Warminster, PA. Flight Dynamics Branch.
AGILITY: A RATIONAL DEVELOPMENT OF FUNDAMENTAL METRICS AND THEIR RELATIONSHIP TO FLYING QUALITIES
C. J. MAZZA *In* AGARD, Flying Qualities 7 p Feb. 1991
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The results of the first phase of a three year agility program are presented. A highly valuable approach was produced for developing a rational concept of agility and for relating agility to the flight dynamics, maneuvering performance, and to the design of the aircraft. The flight mechanics of a rigid aircraft in three-space maneuvering flight are examined with respect to total velocity, acceleration, and the time-rate-of-change of accleration. The terms of the expanded 'agility vector' are interpreted with regard to their potential for providing a rational basis for the evaluation of any given set of agility metrics and for suggesting, directly, a new set of metrics. A potential form of agility is offered for which a readily acceptable relationship is traced to both flying qualities and maneuvering performance. Author

N91-23130# British Aerospace Public Ltd. Co., Preston (England). Military Aircraft Div.
A REVIEW OF HIGH ANGLE OF ATTACK REQUIREMENTS FOR COMBAT AIRCRAFT
K. MCKAY and M. J. WALKER *In* AGARD, Flying Qualities 12 p Feb. 1991
Copyright Avail: NTIS HC/MF A17; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Design of an aircraft for use at high angles of attack can have major implications on the configuration which is chosen. The objective is to review the implications of designing for high angle of attack on configuration. This naturally leads onto consideration of agility and the criteria which could be used in the early design stages to ensure an aircraft is adequately agile. Author

N91-23131# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).
X-31A AT FIRST FLIGHT
W. B. HERBST *In* AGARD, Flying Qualities 8 p Feb. 1991
Copyright Avail: NTIS HC/MF A17; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The X-31A accomplished its first flight on October 11, 1990. A summary is presented about objectives of this international experimental flight test development program, its status, and follow-on planning. Author

N91-23132 Stanford Univ., CA.
A NEW ARCHITECTURE AND EXPERT SYSTEM FOR AIRCRAFT DESIGN SYNTHESIS Ph.D. Thesis
MASAMI TAKAI 1990 223 p
Avail: Univ. Microfilms Order No. DA9102359

Described here is a new program architecture which satisfies the requirement that preliminary design tools accommodate unprecedented extendability in both the sets of variables used to describe the design and the set of analysis routines. In this architecture, a set of procedural modules are compiled separately and linked with the main executive program. Unlike conventional programs, the subroutines and order of execution are selected by the system during the computation, based on the desired output and on the currently available results in the database. The method can greatly improve the efficiency of aircraft design optimization by generating the computational path for a given objective function and avoiding redundant calculations made by conventional methods with rigid program structures. The quasi-procedural architecture is enhanced by a rule-based expert system. The expert system warns of problems with the current design and suggests solutions to make the design feasible. For design optimization, the expert system can identify the active constraints and suggest a set of design variables to satisfy the constraints while best retaining the objective value. Dissert. Abstr.

N91-23133*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
BUFFET INDUCED STRUCTURAL/FLIGHT-CONTROL SYSTEM INTERACTION OF THE X-29A AIRCRAFT
DAVID F. VORACEK and ROBERT CLARKE Apr. 1991 15 p Presented at the 32nd AIAA Structures, Structural Dynamics, and Materials Conference, Baltimore, MD, 8-10 Apr. 1991 Previously announced in IAA as A91-32012
(NASA-TM-101735; H-1687; NAS 1.15:101735; PAPER-91-1053) Avail: NTIS HC/MF A03 CSCL 01/3

High angle-of-attack flight regime research is currently being conducted for modern fighter aircraft at the NASA Ames Research Center's Dryden Flight Research Facility. This flight regime provides enhanced maneuverability to fighter pilots in combat situations. Flight research data are being acquired to compare and validate advanced computational fluid dynamic solutions and wind-tunnel models. High angle-of-attack flight creates unique aerodynamic phenomena including wing rock and buffet on the airframe. These phenomena increase the level of excitation of the structural modes, especially on the vertical and horizontal stabilizers. With high gain digital flight-control systems, this structural response may result in an aeroservoelastic interaction. A structural interaction on the X-29A aircraft was observed during high angle-of-attack flight testing. The roll and yaw rate gyros sensed the aircraft's structural modes at 11, 13, and 16 Hz. The rate gyro output signals were then amplified through the flight-control laws and sent as commands to the flaperons and rudder. The flight data indicated that as the angle of attack increased, the amplitude of the buffet on the vertical stabilizer increased, which resulted in more excitation to the structural modes. The flight-control system sensors and command signals showed this increase in modal power at the structural frequencies up to a 30 degree angle-of-attack. Beyond a 30 degree angle-of-attack, the vertical stabilizer response, the feedback sensor amplitude, and control surface command signal amplitude remained relatively constant. Data are presented that show the increased modal power in the aircraft structural accelerometers, the feedback sensors, and the command signals as a function of angle of attack. This structural interaction is traced from the aerodynamic buffet to the flight-control surfaces. Author

N91-23134# Systems Control Technology, Inc., Arlington, VA.
AIR AMBULANCE HELICOPTER OPERATIONAL ANALYSIS Final Report
ROBERT NEWMAN May 1991 168 p
(Contract DTFA01-87-C-00014)
(DOT/FAA/RD-91/7) Avail: NTIS HC/MF A08

This study of visual flight rules (VFR) weather minimums and operational areas for helicopter emergency medical service operators is based on operator responses to a questionnaire. The national average VFR operational weather minimums for all respondents was determined. Also, an estimate of the percentage of time that each respondent can not fly because of ceiling and/or visibility below their VFR operating minimums was determined, as was the average percentage of time all responders can not fly. Analysis of the data indicated that on the average the operators have voluntarily adopted stricter minimums than recommended in the current FAA Advisory Circular (AC) 135-14, 'Emergency Medical Services/Helicopter (EMS/H).' Furthermore, the analysis indicated that on the average the operators have more restrictive daylight minimums than those in the proposed change to AC 135-14 and less restrictive night minimums than those in the proposed change. Some general observations about minimums for operations in mountainous areas are also provided. The coverage areas reported by the operators were plotted on two maps of the United States, one for the local coverage areas and one for the cross country coverage areas. From these maps, the percentage of coverage for the conterminous United States, each FAA region, and each state were determined. The weather data were also averaged over each state and used to determine the percentage of time that coverage is available in areas where EMS/H service is provided. The FAA is in the process of determining if there is an economic justification for the improvement of low altitude communication, navigation, and surveillance services within the National Airspace System (NAS). A recent FAA survey, Rotorcraft Low Altitude CNS Benefit/Cost Analysis (DOT/FAA/DS-89-11, Sept. 1989) found that the helicopter ambulance mission is a source of significant social benefit. The results of the Air Ambulance Helicopter Operational Analysis provides data which will support further analysis of the benefits of air ambulance helicopters in an IFR environment. Author

N91-23135*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
APPLICATION OF MULTIDISCIPLINARY OPTIMIZATION METHODS TO THE DESIGN OF A SUPERSONIC TRANSPORT
J.-F. M. BARTHELEMY, P. G. COEN, GREGORY A. WRENN, M. F. RILEY, AUGUSTINE R. DOVI, and L. E. HALL (Unisys Corp., Detroit, MI.) Mar. 1991 7 p Presented at the North Atlantic Treaty Organization-AGARD Structures and Materials Panel Meeting, Bath, England, 1-2 May 1991
(NASA-TM-104073; NAS 1.15:104073) Avail: NTIS HC/MF A02 CSCL 01/3

An optimization design method is discussed. This method is based on integrating existing disciplinary analysis and sensitivity analysis techniques by means of generalized sensitivity equations. A generic design system implementing this method is described. The system is being used to design the configuration and internal structure of a supersonic transport wing for optimum performance. This problem combines the disciplines of linear aerodynamics, structures, and performance. Initial results which include the disciplines of aerodynamics and structures in a conventional minimum weight design under static aeroelastic constraints are presented. Author

N91-23136*# McDonnell-Douglas Helicopter Co., Mesa, AZ.
TECHNOLOGY NEEDS FOR HIGH-SPEED ROTORCRAFT
JOHN RUTHERFORD, MATTHEW OROURKE, CHRISTOPHER MARTIN, MARC LOVENGUTH, and CLARK MITCHELL Apr. 1991 245 p
(Contract NAS2-13070)
(NASA-CR-177578; NAS 1.26:177578; L9KVAE-FR-91001) Avail: NTIS HC/MF A11 CSCL 01/3

A study to determine the technology development required for

high-speed rotorcraft development was conducted. The study begins with an initial assessment of six concepts capable of flight at, or greater than 450 knots with helicopter-like hover efficiency (disk loading less than 50 pfs). These concepts were sized and evaluated based on measures of effectiveness and operational considerations. Additionally, an initial assessment of the impact of technology advances on the vehicles attributes was made. From these initial concepts a tilt wing and rotor/wing concepts were selected for further evaluation. A more detailed examination of conversion and technology trade studies were conducted on these two vehicles, each sized for a different mission. Author

N91-23137# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.). Hauptabt. Verkehrsforschung.
THE LIMITS OF THE LANDING PROCESS OF AIRCRAFT
HANNS-JUERGEN PETERS Apr. 1990 120 p In GERMAN; ENGLISH summary
(DLR-FB-90-49; ISSN-0939-2963; ETN-91-99069) Avail: NTIS HC/MF A06; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 45 DM

A Monte Carlo model is used for examining the aircraft landing process. Distributions of arrivals in Terminal Maneuvering Area (TMA) and admissible minimal distances in final approach are the input data. The arrival distribution of some airports are replaced by the Poisson distribution, which is modified by variation of its parameter lambda. In the model, the aircraft distances can be changed by integer steps of one minute. Different distances are necessary to meet German special safety rules, with respect to air vortices caused by preflying aircraft. Results yielded are the maximal numbers of aircrafts in final approach, average rates of landings per hour depending on lambda, and aircraft distances. ESA

N91-23138# Aeronautical Research Inst. of Sweden, Stockholm. Structures Dept.
LONG TIME MEASUREMENTS OF LANDING GEAR LOADS ON SAAB SF-340 COMMUTER AIRCRAFT
A. I. GUSTAVSSON, A. F. BLOM, and L. HELMERSSON (Saab-Scania, Linkoping, Sweden) Dec. 1990 27 p Sponsored by Swedish Board for Technical Development; Swedish Civil Aviation Administration; and Saab-Scania, Linkoeping, Sweden
(FFA-TN-1990-53; ETN-91-99107) Avail: NTIS HC/MF A03

Strain gauge measurements of forces acting on the nose gear and main gears of the commuter aircraft SAAB SF-340 are reported. During initial flight tests, forces in the longitudinal, transversal, and vertical directions were measured for various maneuvers such as takeoff, landing, taxiing, and towing. The investigation revealed high transversal loads at the main gears at touch down. The nose gear is most severely strained when steering during taxiing run and when the aircraft is towed connected to a tractor with a tow bar. The results from such initial measurements formed the basis for a subsequent investigation with on line data acquisition of landing gear loads on a commuter aircraft in service at Swedair AB. The data acquisition system and the data analysis methods are described. The data acquisition was continuously carried out during nearly six months including various parameters such as different aircraft weight and static landing gear loads. Results from these measurements are presented as cumulative exceedances of longitudinal, transversal, and vertical loads obtained from the rainflow count analyses performed online during the measurements. ESA

N91-23140# Cranfield Inst. of Tech., Bedford (England). Dept. of Aerodynamics.
THE PERFORMANCE OF 60 DEG DELTA WINGS: THE EFFECTS OF LEADING EDGE RADIUS AND VORTEX FLAPS
B. K. HU and J. L. STOLLERY Nov. 1989 24 p
(CRANFIELD-AERO-9002; ISBN-1-871564-03-4; ETN-91-99332) Avail: NTIS HC/MF A03

Low speed wind tunnel tests were conducted on sharp edge flat 60 deg delta wing, the wing with leading edge vortex flap deflected 30 deg and 60 deg delta wing with well rounded leading edge to estimate the effects of leading edge vortex flap and leading edge radius on the aerodynamic performance of 60 deg delta wings. Results indicate that the leading edge vortex flap can increase lift/drag ratio of up to 19 pct., well rounded leading edge can increase further lift/drag ratio of up to 39 pct. ESA

N91-23141# Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
ANALYTICAL STUDY OF THE EFFECTS OF WEIGHT ON LIGHT HELICOPTER (LH) EXPOSURE TO GROUND-BASED WEAPONS Final Report, Aug. 1989 - Apr. 1990
CHARLES D. HAHN and KEN G. HALL Jan. 1991 151 p
(AD-A232024; WES/TR/EL-91-2) Avail: NTIS HC/MF A08 CSCL 01/3

In support of the U.S. Army Light Helicopter (LH) Program, the U.S. Army Engineer Waterways Experiment Station (WES) was directed by the U.S. Army Laboratory Command Survivability Management Office (SMO) to simulate typical LH missions using the WES Helicopter Mission Survivability (HELMS) Model and to determine the effect of increasing weight on aircraft exposure to ground-based weapons. This report describes the HELMS model and the missions simulated as well as the terrain used for the simulations. Simulation data are presented as well as the results of the study. GRA

N91-23143# Naval Postgraduate School, Monterey, CA.
DESIGN AND CONSTRUCTION OF A COMPOSITE AIRFRAME FOR UAV RESEARCH M.S. Thesis
JEFFREY L. ELLWOOD Jun. 1990 86 p
(AD-A232422) Avail: NTIS HC/MF A05 CSCL 01/3

A half-scale Unmanned Aerial Vehicle (UAV) was designed and constructed from composite materials for the Flight Research Lab at the Naval Postgraduate School. The vehicle was designed as a technology demonstrator for two studies. First, the Tilted Ducted Fan (TDF) vertical flight capability engine and its stability and control systems, and second, for the tail configuration testing for longitudinal and lateral-directional stability enhancement of an existing tailless Unmanned Aerial Vehicle. Completion of these research and test objectives should provide the configuration requirements for a full-scale development vehicle with vertical takeoff and landing with transition to the forward flight mode. GRA

N91-23144# Wright State Univ., Dayton, OH.
A COMPUTER AIDED MULTIVARIABLE CONTROL SYSTEMS DESIGN TECHNIQUE WITH APPLICATION TO AIRCRAFT FLYING QUALITIES Final Report, Aug. 1987 - Aug. 1990
L. R. PUJARA Jan. 1991 175 p
(Contract F33615-87-C-3615)
(AD-A232549; WRDC-TR-90-3069) Avail: NTIS HC/MF A08 CSCL 01/3

A computer aided multivariable control system design technique is developed for matching the frequency response of a compensated loop system with a given desired transfer function matrix over a frequency interval of interest. Two examples of application of the technique are provided as well as a simple robustness analysis of one the application examples. GRA

N91-24137*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COMPUTATIONAL SUPPORT OF THE X-29A ADVANCED TECHNOLOGY DEMONSTRATOR FLIGHT EXPERIMENT
E. G. WAGGONER and B. L. BATES (Vigyan Research Associates, Inc., Hampton, VA.) *In its* Transonic Symposium: Theory, Application and Experiment, Volume 2 p 147-166 Apr. 1989
Avail: NTIS HC/MF A11 CSCL 01/3

Issues and questions associated with the forward swept wing and closely coupled canard are addressed. The primary focus will be on research questions which must be addressed to obtain high quality ground and flight test data. These data will be used in conjunction with computational predictions to complement the

analyses required to comprehensively understand the interacting technologies. Author

N91-24138*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
RESULTS OF CORRELATIONS FOR TRANSITION LOCATION ON A CLEAN-UP GLOVE INSTALLED ON AN F-14 AIRCRAFT AND DESIGN STUDIES FOR A LAMINAR GLOVE FOR THE X-29 AIRCRAFT ACCOUNTING FOR SPANWISE PRESSURE GRADIENT
S. H. GORADIA (Vigyan Research Associates, Inc., Hampton, VA.), P. J. BOBBITT, H. L. MORGAN, J. C. FERRIS, and WILLIAM D. HARVEY *In its* Transonic Symposium: Theory, Application and Experiment, Volume 2 p 167-227 Apr. 1989
Avail: NTIS HC/MF A11 CSCL 01/1

Results of correlative and design studies for transition location, laminar and turbulent boundary-layer parameters, and wake drag for forward swept and aft swept wings are presented. These studies were performed with the use of an improved integral-type boundary-layer and transition-prediction methods. Theoretical predictions were compared with flight measurements at subsonic and transonic flow conditions for the variable aft swept wing F-14 aircraft for which experimental pressure distributions, transition locations, and turbulent boundary-layer velocity profiles were measured. Flight data were available at three spanwise stations for several values of sweep, freestream unit Reynolds number, Mach numbers, and lift coefficients. Theory/experiment correlations indicate excellent agreement for both transition location and turbulent boundary-layer parameters. The results of parametric studies performed during the design of a laminar glove for the forward swept wing X-29 aircraft are also presented. These studies include the effects of a spanwise pressure gradient on transition location and wake drag for several values of freestream Reynolds numbers at a freestream Mach number of 0.9. Author

N91-24158# Wichita State Univ., KS.
FEASIBILITY STUDY IN CRACK DETECTION IN AIRCRAFT STIFFENED PANELS BY PULSE PROBING AND DECONVOLUTION
JORGE E. TALIA, BEHNAM BAHR, and HAMID M. LANKARANI *In its* Program Plans for Aviation Safety Research 6 p Dec. 1990
Avail: NTIS HC/MF A04

The main objective is to assess the use of changes in dynamic characteristics of a structure or its spectroscopy to detect crack formation. The first approach is to excite the structure harmonically over a range of frequencies and recover the natural frequencies of vibration and modal damping parameters from the analysis of the steady state responses. The preferred approach is to excite the structure with an appropriate pulse and extract the dynamic Green's function from the corresponding transient response. Author

N91-24195*# Douglas Aircraft Co., Inc., Long Beach, CA.
THE 1989 HIGH-SPEED CIVIL TRANSPORT STUDIES
Washington NASA May 1991 103 p
(Contract NAS1-18378)
(NASA-CR-4375; NAS 1.26:4375) Avail: NTIS HC/MF A06 CSCL 01/3

The results are presented for the Douglas Aircraft Company system studies related to high speed civil transports (HSCTs). The system studies were conducted to assess the environmental compatibility of a HSCT at a design Mach number of 3.2. Sonic boom minimization, exterior noise, and engine emissions were assessed together with the effect of a laminar flow control (LFC) technology on vehicle gross weight. The general results indicated that (1) achievement of a 90 PLdB sonic boom loudness level goal at Mach 3.2 may not be practical; (2) the high flow engine cycle concept shows promise of achieving the side line FAR Part 36 noise limit but may not achieve the aircraft range design goal of 6,500 nautical miles; (3) the rich burn/quick quench (RB/QQ) combustor concept shows promise for achieving low EINO(sub x) levels when combined with a premixed pilot stage/advanced technology high power stage duct burner in the P and W variable stream control engine (VSCE); and (4) full chord wing LFC has significant performance and economic advantages relative to the turbulent wing baseline. Author

N91-24196*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A SYSTEM APPROACH TO AIRCRAFT OPTIMIZATION
JAROSLAW SOBIESZCZANSKI-SOBIESKI Mar. 1991 17 p Presented at the NATO-AGARD Structures and Materials Panel Meeting, Bath, England, 28 Apr. - 5 May 1991
(NASA-TM-104074; NAS 1.15:104074) Avail: NTIS HC/MF A03 CSCL 01/3

Mutual couplings among the mathematical models of physical phenomena and parts of a system such as an aircraft complicate the design process because each contemplated design change may have a far reaching consequence throughout the system. Techniques are outlined for computing these influences as system design derivatives useful for both judgemental and formal optimization purposes. The techniques facilitate decomposition of the design process into smaller, more manageable tasks and they form a methodology that can easily fit into existing engineering organizations and incorporate their design tools. Author

N91-24197# Air Force Flight Dynamics Lab., Wright-Patterson AFB, OH.
THE EFFECTS ON AERODYNAMIC PERFORMANCE OF DESIGNING SUPERSONIC WINGS FOR LAMINAR FLOW CONTROL Interim Report
CARL P. TILMANN 30 Jan. 1991 90 p
(AD-A233040; WL-TM-91-303) Avail: NTIS HC/MF A05 CSCL 01/1

A preliminary technique has been developed for the design of wings to be used with supersonic hybrid method laminar flow control systems. This technique has been used to evaluate the effects on aerodynamic performance of designing supersonic wings for laminar flow control. In this design method, a wing is cambered such that it produces and upper-surface streamwise pressure distribution which is favorable for use in a hybrid laminar flow control (HLFC) system, while maintaining a spanwise lifting distribution which will minimize drag-due-to-lift. An existing linear-theory computer program is used to calculate the wing camber definition that produces a desired pressure distribution on the upper surface of the wing with a specified thickness profile. This method was applied to an array of arrow-wings varying in aspect ratio and taper ratio. Each wing planform was then camber-optimized for minimum cruise drag-due-to-lift using current preliminary wing design methods, which optimize the wing's camber of lifting load distribution without regard to the boundary layer type. The total drag of each wing is then estimated by the superposition of zero-lift wave drag, skin friction drag, and drag-due-to-lift. The true effectiveness of laminar flow control wings could then be evaluated by weighing the benefit of the reduced friction drag against the penalty of increased drag-due-to-lift which would be displayed by a wing designed for a laminar flow control system. GRA

N91-24198*# Advanced Technologies, Inc., Newport News, VA.
SOFT HUB FOR BEARINGLESS ROTORS
PETER G. C. DIXON Jun. 1991 98 p
(Contract NAS2-13157)
(NASA-CR-177586; A-91158; NAS 1.26:177586) Avail: NTIS HC/MF A05 CSCL 01/3

Soft hub concepts which allow the direct replacement of articulated rotor systems by bearingless types without any change in controllability or need for reinforcement to the drive shaft and/or transmission/fuselage attachments of the helicopter were studied. Two concepts were analyzed and confirmed for functional and structural feasibility against a design criteria and specifications established for this effort. Both systems are gimballed about a thrust carrying universal elastomeric bearing. One concept includes a set of composite flexures for drive torque transmittal from the shaft to the rotor, and another set (which is changeable) to impart

hub tilting stiffness to the rotor system as required to meet the helicopter application. The second concept uses a composite bellows flexure to drive the rotor and to augment the hub stiffness provided by the elastomeric bearing. Each concept was assessed for weight, drag, ROM cost, and number of parts and compared with the production BO-105 hub. Author

N91-24199*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EVALUATION OF CLOUD DETECTION INSTRUMENTS AND PERFORMANCE OF LAMINAR-FLOW LEADING-EDGE TEST ARTICLES DURING NASA LEADING-EDGE FLIGHT-TEST PROGRAM
RICHARD E. DAVIS, DAL V. MADDALON, RICHARD D. WAGNER, DAVID F. FISHER, and RONALD YOUNG (National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.) Apr. 1989 58 p
(NASA-TP-2888; L-16509; NAS 1.60:2888) Avail: NTIS HC/MF A04 CSCL 01/3

Summary evaluations of the performance of laminar-flow control (LFC) leading edge test articles on a NASA JetStar aircraft are presented. Statistics, presented for the test articles' performance in haze and cloud situations, as well as in clear air, show a significant effect of cloud particle concentrations on the extent of laminar flow. The cloud particle environment was monitored by two instruments, a cloud particle spectrometer (Knollenberg probe) and a charging patch. Both instruments are evaluated as diagnostic aids for avoiding laminar-flow detrimental particle concentrations in future LFC aircraft operations. The data base covers 19 flights in the simulated airline service phase of the NASA Leading-Edge Flight-Test (LEFT) Program. Author

N91-24200*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NASA-LARC FLIGHT-CRITICAL DIGITAL SYSTEMS TECHNOLOGY WORKSHOP
C. W. MEISSNER, JR., ed., J. R. DUNHAM, ed., and G. CRIM, ed. Apr. 1989 191 p Workshop held in Hampton, VA, 13-15 Dec. 1988
(NASA-CP-10028; REPT-412U-3181-29; NAS 1.55:10028) Avail: NTIS HC/MF A09 CSCL 01/3

The outcome is documented of a Flight-Critical Digital Systems Technology Workshop held at NASA-Langley December 13 to 15 1988. The purpose of the workshop was to elicit the aerospace industry's view of the issues which must be addressed for the practical realization of flight-critical digital systems. The workshop was divided into three parts: an overview session; three half-day meetings of seven working groups addressing aeronautical and space requirements, system design for validation, failure modes, system modeling, reliable software, and flight test; and a half-day summary of the research issues presented by the working group chairmen. Issues that generated the most consensus across the workshop were: (1) the lack of effective design and validation methods with support tools to enable engineering of highly-integrated, flight-critical digital systems, and (2) the lack of high quality laboratory and field data on system failures especially due to electromagnetic environment (EME). Author

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A91-36755
FIRE DETECTION SYSTEM FOR AIRCRAFT CARGO BAYS
MICHAEL L. PARSONS, PETER HUTCHINS, and VINCENT Y. TSENG (Pacific Scientific Co., HTL/Kin-Tech Div., Duarte, CA) IN: Infrared detectors and focal plane arrays; Proceedings of the Meeting, Orlando, FL, Apr. 18, 19, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 312-324. refs
Copyright

The paper presents a fire detection system meeting the FAA regulations, based on infrared detection technology coupled with a Fresnel scanning optical system. The system utilizes a dual-computer controller unit, and its sensor is responsive to either overheating or fire conditions. Attention is given to such system components as a thermal imaging module, scan motor, infrared detector, amplifier, decision and fault-detection logic, and interfaces. Controller functions and communications are outlined as well as system timing. Performance characteristics and compliance with the FAA regulations are discussed. V.T.

A91-38542#
VELOCITY SENSOR FOR AN AIRBORNE OPTICAL AIR DATA SYSTEM
ANTHONY E. SMART (Spectron Development Laboratories, Costa Mesa, CA) Journal of Aircraft (ISSN 0021-8669), vol. 28, March 1991, p. 163, 164.
Copyright

The feasibility of an optical air data sensor (OADS) based on sheet-pair transit-time velocimetry has been demonstrated on an F-16 from sea level to 50,000 ft and up to supersonic speeds during exposure to bright sunlight, clouds, and smoke. Measurements corresponded well with conventional pneumatic airspeed and attitude measurements, with significantly better response time and data rates exceeding 100/s. The prototype system proved reliable on all flights and retained acceptable calibration. Author

A91-39387
ADVANCED AIRBORNE OXYGEN SENSORS
M. W. HARRAL (Normalair-Garrett, Ltd., Yeovil, England) IN: Annual SAFE Symposium, 27th, New Orleans, LA, Dec. 5-8, 1989, Proceedings. Newhall, CA, SAFE Association, 1990, p. 129-134.
Copyright

This paper discusses the development of an advanced oxygen sensor. A study of the available technology was undertaken and solid-electrolyte (zirconia) sensors were indentified as the most suitable candidates for aircraft applications. Following a program of laboratory tests, a potentiometric type of sensor was selected for use in a flight-weight prototype monitor. This unit has completed safety-of-flight testing and will be flown in late 1989 on the British Aerospace Experimental Aircraft Programme demonstrator aircraft. Author

A91-39873*# Lockheed Missiles and Space Co., Palo Alto, CA.
COHERENT LIDAR AIRBORNE WINDSHEAR SENSOR - PERFORMANCE EVALUATION
RUSSELL TARG (Lockheed Missiles and Space Co., Inc., Palo Alto, CA), MICHAEL J. KAVAYA, R. MILTON HUFFAKER (Coherent Technologies, Inc., Boulder, CO), and ROLAND L. BOWLES (NASA, Langley Research Center, Hampton, VA) Applied Optics (ISSN 0003-6935), vol. 30, May 20, 1991, p. 2013-2026. refs
(Contract NAS1-18029)
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As part of the NASA/FAA National Integrated Windshear Program, a measurable windshear hazard index has been defined that can be remotely sensed from an aircraft, to give the pilot information about the wind conditions along the flight path. A technology analysis and end-to-end performance simulation measuring signal-to-noise ratios and resulting wind velocity errors for competing coherent laser radar (lidar) systems have been carried out. The results show that a Ho:YAG lidar at a wavelength of 2.1 microns and a CO2 lidar at 10.6 microns can give the pilot information about the line-of-sight component of a windshear threat from his present position to a region extending 2-4 km in front of the aircraft. This constitutes a warning time of 20-40 s, even in conditions of moderately heavy precipitation. Author

A91-39890
MODEL FOR IR SENSOR PERFORMANCE EVALUATION - APPLICATIONS AND RESULTS
W. T. KREISS (Horizons Technology, Inc., San Diego, CA), A. TCHOUBINEH (U.S. Navy, Pacific Missile Test Center, Point Mugu, CA), and W. LANICH (USAF, Wright Research and Development Center, Wright-Patterson AFB, OH) IN: Infrared imaging systems: Design, analysis, modeling, and testing; Proceedings of the Meeting, Orlando, FL, Apr. 16-18, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 190-207. Research sponsored by USAF and U.S. Navy.
Copyright
This paper presents the results of initial testing of a computer simulation model which has been designed for use by persons not necessarily expert in all or any of the disciplines involved in signature analysis, and which can be utilized for evaluating sensor system performance and prediction of sensor acquisition ranges. The ATIMS III airborne turret infrared measurement system, flight experiments, and the IASPM simulation model are described. Analysis of preliminary results comparing experimental data with simulated data for the 2 - 5 and 8 - 12 micron IR bands reveal the potential of the model for simulating a multitude of sensor-observed phenomena. Model strengths and shortcomings are discussed. Author

A91-40550
ALONG FOR THE RIDE?
GARY STIX Scientific American (ISSN 0036-8733), vol. 265, July 1991, p. 94-99, 102, 104, 106. refs
Copyright
The expanded role of computers in the newest generation of jet aircraft is discussed. The development of automation in aircraft from the early 20th century to the present is reviewed, and the need for further automation is pointed out. The effect of extensive automation on the cockpit crew is assessed. C.D.

N91-23145# Naval Postgraduate School, Monterey, CA.
AN ENGINEERING STUDY OF ALTITUDE DETERMINATION DEFICIENCIES OF THE SERVICE AIRCRAFT INSTRUMENTATION PACKAGE (SAIP) M.S. Thesis
STEVEN R. EASTBURG 1991 125 p
(AD-A232055) Avail: NTIS HC/MF A06 CSCL 01/4
Altitude determination errors of the U.S. Navy's Service Aircraft Instrumentation Package (SAIP), an airborne positioning pod, were examined in a multifaceted study involving in-flight evaluations, wind tunnel testing, and pressure sensitivity experiments. The original objectives of the research related to identifying aerodynamic sources of pod static pressure inaccuracies and recommending specific remedies to alleviate these errors. After an extensive evaluation, results revealed that the problem exists not in the aerodynamic measurement performance of the probe, but in the electronic circuitry residing within the Air Data Unit (ADU). The ADU houses multiple pressure transducers, each associated with different static and dynamic pressure ports, in a single module. This circuit configuration leads to electrical interference and an attendant degradation of the static pressure output voltage. Accurate static pressure voltages, which can be subsequently converted into appropriate SAIP barometric altitudes, are obtained by electrically isolating the three ADU dynamic pressure transducers from the single operative static pressure transducer and remaining ADU circuitry. GRA

N91-23146# United Technologies Corp., West Palm Beach, FL. Sikorsky Aircraft Div.
MECHANICAL COMPONENT DIAGNOSTIC SYSTEM Final Report, Oct. 1987 - May 1990
R. A. SEWERSKY Jan. 1991 56 p
(Contract DAAJ02-87-C-0015)
(AD-A232126; SER-701-640; AVSCOM-TR-90-D-24) Avail: NTIS HC/MF A04 CSCL 01/3
The Mechanical Component Diagnostic System (MCDS) research and development (R and D) program was designed to investigate and demonstrate the benefits of onboard data recording/processing and rotor tuning equipment for monitoring and diagnosis of mechanical subsystems on rotorcraft. The payoffs for such a concept include reduced aircraft vibration levels (with extended MTBF of electronics and mechanical systems as well as reduced crew fatigue), reduced maintenance flights, and early warning of component failures. This program demonstrates an approach to a practical, automated system which monitors certain mechanical subsystems, provides inflight vibration and control system status, and prescribes corrective actions to the maintainer. Various monitoring components were developed and integrated to demonstrate the concept. GRA

07

AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and on-board auxiliary power plants for aircraft.

A91-37593* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SENSOR FAILURE DETECTION FOR JET ENGINES
WALTER C. MERRILL (NASA, Lewis Research Center, Cleveland, OH) IN: Control and dynamic systems. Vol. 33 - Advances in aerospace systems dynamics and control systems. Pt. 3. San Diego, CA, Academic Press, Inc., 1990, p. 1-34. Previously announced in STAR as N89-13432. refs
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The use of analytical redundancy to improve gas turbine engine control system reliability through sensor failure detection, isolation, and accommodation is surveyed. Both the theoretical and application papers that form the technology base of turbine engine analytical redundancy research are discussed. Also, several important application efforts are reviewed. An assessment of the state-of-the-art in analytical redundancy technology is given.
Author

A91-38007
ADVANCED AIRCRAFT SECONDARY POWER SYSTEM DESIGN
E. J. WOODS, I. S. MEHDI (Boeing Co., Seattle, WA), and C. S. RUBERTUS (USAF, Wright Research and Development Center, Wright-Patterson AFB, OH) IN: IECEC-90; Proceedings of the 25th Intersociety Energy Conversion Engineering Conference, Reno, NV, Aug. 12-17, 1990. Vol. 1. New York, American Institute of Chemical Engineers, 1990, p. 505-510. USAF-supported research. refs
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The requirements, the secondary power system design, and the results of a trade study for an advanced aircraft secondary power system design (AASPSD) are described. The aircraft selected for this study was a Mach 6 vehicle. The three AASPSD configurations studied were a conventional system with hydraulic actuation and turbine-driven fuel pumps, a more-electric system with electromechanical actuators (EMAs) and turbine-driven fuel pumps, and an all-electric system with EMAs and electrically driven fuel pumps. The electrical system for each of the configurations utilized a three-channel architecture feeding electrical load management centers (ELMCs). The trade study results on these three system configurations included comparison of weight, volume, reliability, redundance, cost, and performance. It is concluded that the three systems investigated in the detailed design phase of the contract will provide adequate redundancy, reliability, survivability, and performance. The more-electric system is shown to have a definite advantage in weight and cost, and the highest score in the trade study. The all-electric system provides a lower overall mean time between failure. This should be reflected in lower maintenance costs and better flight readiness over the life of the aircraft. I.E.

A91-38037
AIRCRAFT ELECTRICAL SYSTEM COMPUTER SIMULATION
E. J. WOODS (Boeing Co., Seattle, WA) IN: IECEC-90; Proceedings of the 25th Intersociety Energy Conversion Engineering Conference, Reno, NV, Aug. 12-17, 1990. Vol. 2. New York, American Institute of Chemical Engineers, 1990, p. 84-89. refs
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Computer simulation results are presented for a single channel of an aircraft electrical system with rectified power loads. The computer model included a generator, ac load with resistance and inductance, and a resistive dc load. Generator models included a wound field model with field control and direct and quadrature axis damper windings, a simplified permanent magnet generator with mutual inductance between stator windings, and a simplified wound field model with mutual inductances and field control. The simulation was implemented on EASY5, a modeling program which utilizes both standard components and user-generated FORTRAN components. The rectifier and some generator models were implemented as FORTRAN components. Steady-state computer runs for the system included various ac and dc load levels. Loads were switched to produce transient conditions. The results are presented in the form of computer-generated plots which show system response. I.E.

A91-38178
PRISMATIC SEALED NI-CD BATTERY FOR AIRCRAFT POWER
MENAHEM ANDERMAN (Acme Advanced Energy Systems, Tempe, AZ), GABOR BENCZUR-URMOSSY, and FRIEDRICH HASCHKA (Deutsche Automobilgesellschaft mbH, Esslingen, Federal Republic of Germany) IN: IECEC-90; Proceedings of the 25th Intersociety Energy Conversion Engineering Conference, Reno, NV, Aug. 12-17, 1990. Vol. 6. New York, American Institute of Chemical Engineers, 1990, p. 143-148.
Copyright

A fast-charging high-power prismatic sealed Ni-Cd battery with a fiber structured electrode has been developed. The battery is designed to exceed essentially all performance attributes of a vented sintered plate aircraft battery, yet it will not require any maintenance. The flexible integrity of the fiber structure electrode supports thousands of deep cycles without electrode degradation. Over 5000 cycles have been measured on vented fiber nickel-cadmium (FNC) cells at a typical 60 percent depth of discharge test. Data obtained to date suggest that the sealed FNC cells may match this performance. Of particular interest to aircraft applications is the ability of the cell to withstand thousands of short high-current loads during the start of an aircraft engine. Data obtained in such tests are discussed. I.E.

A91-38203#
EXPERIMENTAL INVESTIGATION ON SUPERSONIC COMBUSTION
XINGZHOU LIU, JINGHOU LIU, YUREN WANG, YUNQI GE, and LIXIN YANG (31st Research Institute, People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), April 1991, p. 1-8. In Chinese, with abstract in English. refs

An experimental investigation with a model scramjet combustor which consists of a rearward-facing step and a diverging duct was carried out by using electric arc-heated air to simulate combustor inlet Mach number 2.1, total pressure 0.7 MPa, and total temperature 1200 K. The fuel was injected parallel or perpendicular to the airstream. Both kerosene and hydrogen can burn steadily within a wide range of fuel-air equivalence ratio, and their combustion state was compared. Author

A91-38207#
CYCLE ANALYSIS FOR A SUPERSONIC THROUGH FLOW FAN ENGINE
PENG SHAN and DEPING TAO (Beijing University of Aeronautics and Astronautics, People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), April 1991, p. 31-39. In Chinese, with abstract in English. refs

A computer program for evaluating supersonic throughflow (STF) fan engine thermodynamic quality and optimizing the cycle variables has been developed. Results from applying the program to an STF fan engine equipped for transport with cruise Mach number 2.7 are reported. At cruise conditions, the specific fuel consumption is 2 percent or more lower in the STF fan engine than in the conventional turbofan engine and 8 percent or more lower than in the turbojet engine. At takeoff conditions, the STF fan engine has lower specific fuel consumption than the other types. When the entrance area of the STF fan inlet is designed at the takeoff state for a transport mission profile, the mass flow at other mission states can be fully obtained. C.D.

A91-38209#
ON DIGITAL ELECTRONIC CONTROL SYSTEM OF AIRCRAFT ENGINE
JUNXIANG LIANG (MAS, Research Institute of Technology and Economics, People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), April 1991, p. 46-52. In Chinese, with abstract in English. refs

A full-authority digital electronic control system research program with WP-13 as a technology demonstrator was established to provide advanced technology for coming airbreathing engine control systems. The scope of the research program includes control theory and methodology, real-time control system simulation, automated fault detection, isolation, and reconfiguration algorithm, built-in digital electronic engine controller with functional and hardware redundancy, sensing and actuating systems, and full governing hydromechanical backup control. The paper presents an outline of the program: the motivation of the research, general system description, the goals and technology needs and progress, and the prospects. Author

A91-39201
DESIGN AND DEVELOPMENT OF AVIATION GAS TURBINE ENGINES [KONSTRUKTSIIA I PROEKTIROVANIE AVIATSIONNYKH GAZOTURBINNYKH DVIGATELEI]
SERGEI A. V'IUNOV, IURII I. GUSEV, ALEKSEI V. KARPOV, A. E. KOVALEVSKAIA, IU. M. NIKITIN et al. Moscow, Izdatel'stvo Mashinostroenie, 1989, 568 p. In Russian. refs
Copyright

The fundamentals of the design and development of aviation gas turbine engines are presented from the standpoint of the complex solution of design, layout, and engineering problems. The discussion covers the principal design requirements and specifications of gas turbine engines, the main stages of engine design and development, computer-aided design, and the principles of modular design. Attention is also given to the principles governing the design of the main components of gas turbine engines, including compressors, rotors, blading, blade-cooling systems, combustion chambers, nozzles, drives, and lubrication systems. V.L.

N91-23147# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Propulsion and Energetics Panel.
HYPERSONIC COMBINED CYCLE PROPULSION
Dec. 1990 474 p In ENGLISH and FRENCH Symposium held in Madrid, Spain, 28 May - 1 Jun. 1990
(AGARD-CP-479; ISBN-92-835-0594-8) Copyright Avail: NTIS HC/MF A20; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The proceedings of the symposium are presented. The symposium was arranged in the following sessions: (1) Technical review of hypersonic propulsion/mission requirements; (2) Propulsion concepts; (3) Air intake flow; (4) Turbomachinery; (5) Combustion and ram/scramjets; (6) Nozzle flow; and (7) High temperature materials. The present status in the broad subject of contributing to hypersonic combined cycle propulsion is discussed. Considerable progress in design and analysis, using computational fluid dynamics techniques are reported.

N91-23148# Sener S.A., Madrid (Spain).
HYPERSONIC PROPULSION: PAST AND PRESENT

C. SANCHEZTARIFA *In* AGARD, Hypersonic Combined Cycle Propulsion 24 p Dec. 1990
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The change in the concept of hypersonic speed with time is briefly discussed. The evolution of the hypersonic propulsion is restricted to the history of the ramjets. Considering the abundance of literature on the subject, only the most remarkable achievements are reviewed. Less divulged historical events, such as the propulsion of helicopters by ramjets, are discussed in more detail, and special attention is given to the contributions of Spain to supersonic combustion. The present state of the hypersonic propulsion is examined. Some of the most demanding problems facing the propulsion system of the Aerospace Plane and the Hypersonic Cruise Aircraft are reviewed. Author

N91-23149# Office National d'Etudes et de Recherches Aerospatiales, Modane (France).
A STUDY OF SUPERSONIC AND HYPERSONIC RAMJET ENGINES IN FRANCE FROM 1950 TO 1974 (APPLICATION ON COMBINED CYCLE AIRCRAFT ENGINES) [L'ETUDE DU STATOREACTEUR SUPERSONIQUE ET HYPERSONIQUE EN FRANCE DE 1950 A 1974 (APPLICATION AUX MOTEURS COMBINES AEROBIES)]
ROGER MARGUET, PIERRE BERTON, and FRANCIS HIRSINGER *In* AGARD, Hypersonic Combined Cycle Propulsion 16 p Dec. 1990 In FRENCH
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France has the potential for theoretical and experimental research on the ramjet engine which would allow its operational programs such as ASMP (Air Surface Medium Range by nuclear stress). The direction of these studies evolved trends for the future, especially in the area of very high speed and the use of combined engines. This is due in large part to significant national action on the ramjet engine during the period of 1951 to 1972, during which a number of flight tests or ground tests has proven the concepts of the conventional ramjet engine and the combined turbo-ramjet, as well as the dual mode hypersonic ramjet, the latter comes from a subsonic combustion after supersonic. These fixed point tests, on a large scale, were done in the ONERA wind tunnel at Modane. At the request of the organizers of the symposium, the status, main work, and results are reviewed which was conducted during this period in France. An analysis is made of the data. It is hoped that it will lead to more research on the hypersonic propulsion ramjet engine. Transl. by E.R.

N91-23151# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.). Inst. fuer Antriebstechnik.
TRAJECTORY OPTIMIZATION CONSIDERATIONS FOR RAMJET ENGINES
FRANS G. J. KREMER *In* AGARD, Hypersonic Combined Cycle Propulsion 12 p Dec. 1990
Copyright Avail: NTIS HC/MF A20; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

For supersonic and hypersonic flight conditions with ramjets, trajectory calculations have to be coupled with the engine performances. In space transportation systems ramjet will be used in a relatively wide range of Mach numbers, and therefore not always near the optimum design point. Optimization of several physical parameters along the trajectory will be inevitable. Some of these parameters are discussed along with their importance for an ascent trajectory, having a minimum fuel requirement. Author

N91-23152# Societe Europeenne de Propulsion, Suresnes (France).
COMPARATIVE STUDY OF DIFFERENT SYSTEMS OF COMBINED CYCLE PROPULSION
PHILIPPE RAMETTE, DOMINIQUE SCHERRER, and MICHEL DOUBLIER (Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Suresnes, France) *In* AGARD, Hypersonic Combined Cycle Propulsion 11 p Dec. 1990 In FRENCH; ENGLISH summary
Copyright Avail: NTIS HC/MF A20; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Since 1986 the French Space Agency, CNES, is sponsoring some comparative studies of different concepts of combined cycle engines made jointly by SNECMA, SEP, and ONERA. SNECMA and SEP recently joined their efforts in combined cycle propulsion by creating a common Joint Venture named HYPERSPACE. The recent progress of comparative studies of different combined cycle engine systems is presented focusing on the following concepts: (1) the turborocket family including the turbo rocket-ramjet and the turbo expander-ramjet; (2) the turbojet family with the turbofan-ramjet and the turboramjet; (3) the rocket-ramjet; (4) the liquefied air rocket; (4) the cooled air rocket; and (5) the scramjet which is also presently in progress. The comparison of these concepts include their theoretical performance, some design considerations and an approximate evaluation of the technological difficulties with each concept. Author

N91-23153*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HYPERSONIC PROPULSION: STATUS AND CHALLENGE
R. WAYNE GUY *In* AGARD, Hypersonic Combined Cycle Propulsion 19 p Dec. 1990
Copyright Avail: NTIS HC/MF A20; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive
CSCL 21/5

Scientists in the U.S. are again focusing on the challenge of hypersonic flight with the proposed National Aerospace Plane (NASP). This renewed interest has led to an expansion of research related to high speed airbreathing propulsion, in particular, the supersonic combustion ramjet, or scramjet. The history is briefly traced of scramjet research in the U.S., with emphasis on NASA sponsored efforts, from the Hypersonic Research Engine (HRE) to the current status of today's airframe integrated scramjets. The challenges of scramjet technology development from takeover to orbital speeds are outlined. Existing scramjet test facilities such as NASA Langley's Scramjet Test Complex as well as new high Mach number pulse facilities are discussed. The important partnership role of experimental methods and computational fluid dynamics is emphasized for the successful design of single stage to orbit vehicles. Author

N91-23154# Industrieanlagen-Betriebsgesellschaft m.b.H., Ottobrunn (Germany, F.R.).
AIRBREATHING PROPULSION FOR SPACE TRANSPORT: NEW CONCEPTS, SPECIAL PROBLEMS AND ATTEMPTS AT SOLUTIONS
H. KUENKLER *In* AGARD, Hypersonic Combined Cycle Propulsion 14 p Dec. 1990
Copyright Avail: NTIS HC/MF A20; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The design requirements of airbreathing propulsion for space transport application strongly depend on the particular mission demands and differ markedly from those of conventional airbreathing propulsion systems. Especially the low thrust densities and high thermal loads at high Mach numbers demands a systematic approach to design and selection of possible propulsion concepts. Main problems of propulsion system concepts and of their development as well as to present attempts for possible solutions are discussed. Author

N91-23155# Wright Research Development Center, Wright-Patterson AFB, OH. Turbine Engine Div.
TURBOJET POTENTIAL FOR HYPERSONIC FLIGHT
JEFFREY M. STRICKER and DOUGLAS J. ESSMAN *In* AGARD, Hypersonic Combined Cycle Propulsion 11 p Dec. 1990
Copyright Avail: NTIS HC/MF A20; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Over the past few years, interest in manned hypersonic flight has increased significantly. The disadvantages of a three mode propulsion system (turbojet/ramjet/scramjet) are the complexity, weight, and costs which accompany it. Inlet and exhaust geometry

variations required for proper integration play a major role. The utilization is explored of the turbine engine for aircraft propulsion up to the scramjet transition. Examination of the uninstalled cycle performance is presented as well as an assessment of installed engine operation in a hydrogen fueled aircraft. Both non-afterburning and afterburning turbine engines are compared to turboramjet and air turboramjet (ATR) engines for a Mach 5 long duration cruise mission along with a pure acceleration mission, i.e., the turbomachinery is used to accelerate the vehicle to a Mach number where the scramjet can take over. From this assessment, a baseline engine configuration/cycle is defined for feasibility studies and critical technology identification. A discussion of the feasibility of the perferred concept from an engine component by component standpoint is provided as well as a discussion of technology risk compared to the state of the art. Author

N91-23156# Fiat Aviazione S.p.A., Turin (Italy).
AIRBREATHING PROPULSION FOR TRANSATMOSPHERIC FLIGHT
G. ANDREI, U. BORIO, and M. MAIURANO *In* AGARD, Hypersonic Combined Cycle Propulsion 11 p Dec. 1990
Copyright Avail: NTIS HC/MF A20; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The application of airbreathing propulsion systems to winged launchers is examined. The characteristics of ramjet based, LH2 fueled, powerplants are analyzed. The main ramjet design parameters are highlighted. Options (rockets, turboengines) for the boost phase from takeoff to ramjet mode transition are described, and their potential applicability to Single Stage to Orbit (SSTO) and Two Stage to Orbit (TSTO) launcher is discussed. Author

N91-23157# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
COMPACT HEAT EXCHANGER FOR AN INVERSE COMPONENTS ENGINE [ECHANGEUR COMPACT POUR MONTEUR A COMPOSANTS INVERSES (MCI)]
YVES RIBAUD *In* AGARD, Hypersonic Combined Cycle Propulsion 10 p Dec. 1990 In FRENCH; ENGLISH summary
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A presizing study on a counter current heat exchanger fitted for the inverse components engine (ICE) was performed first using analytical calculations and then with a calculation code. The first calculation results show that the heat exchanger integration on the engine axis seems to be possible without a too great penalty on weight and length. The future main research purpose will be directed towards the reduction of the turbine exhaust section. Author

N91-23158# Aerojet TechSystems Co., Sacramento, CA. Aeropropulsion.
DESIGN CONSIDERATIONS FOR COMBINED AIR BREATHING-ROCKET PROPULSION SYSTEMS
DAVID L. KORS *In* AGARD, Hypersonic Combined Cycle Propulsion 13 p Dec. 1990 Previously announced in IAA as A91-14442
(AIAA-90-0098) Copyright Avail: NTIS HC/MF A20; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Combined air breathing rocket propulsion systems have been studied and carried through proof of principle demonstrations during the last three decades. Currently, a number of countries are studying and in some cases actually starting development of demonstrator vehicles for hypersonic flight which use combinations of air breathing and rocket propulsion. A summary of this activity including the propulsion options being studied is discussed. This type of propulsion is much more revolutionary in nature than most previous propulsion developments and thus results in technology challenges that are even more severe than those faced by either conventional air breathing propulsion or rocket designers. These include: (1) propulsion/vehicle integration; (2) engine stability over a wide operating range; (3) high performance over a wide operating range; (4) system level thermal management; and (5) advanced materials. A discussion of these technical issues including the impact of underachieved development goals on system level performance is also included. Author

N91-23160# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
SUPERSONIC-HYPERSONIC INLET STUDIES FOR AEROSPACEPLANE
C. SANS, P. CHAMPIGNY, P. DUVEAU, and C. GINOVART *In* AGARD, Hypersonic Combined Cycle Propulsion 11 p Dec. 1990 In FRENCH; ENGLISH summary
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Recent improvements in technology have allowed the design of rockets to launch satellites. Reusable shuttles were then used to limit launch costs. A new stage is needed for horizontal takeoff and landing aerospace planes. These single or two stage vehicles will need new propulsion systems, able to provide enough thrust in the whole flight corridor. Mixed propulsion systems seem to be well adapted to this need. During atmospheric flight air breathing engines are necessary to improve performances. Thus inlets will have to be installed. The success of this project will depend on the choice of the inlets, for which mass flow ratios is a paramount objective. Pressure recovery seems to be of less importance at high Mach numbers because of structural stresses. Current design methods are examined which are based on: (1) semiempirical predictions, using experimental data bases, shock boundary layer interaction laws, shock and side overflow losses; (2) 2-D and 3-D Euler codes taking into account the internal bleed effects; and (3) Navier-Stokes codes for specific problems. Some examples of inlet design are presented for rocket ramrocket engines. Problems of inlet integration are presented. Author

N91-23166# Johns Hopkins Univ., Laurel, MD. Applied Physics Lab.
DESIGN TECHNIQUES FOR DUAL MODE RAM-SCRAMJET COMBUSTORS
F. S. BILLIG, S. CORDA, and P. P. PANDOLFINI *In* AGARD, Hypersonic Combined Cycle Propulsion 20 p Dec. 1990
Copyright Avail: NTIS HC/MF A20; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

A disciplined analytical method that describes the different engine operating modes and internal flow structures in dual mode ram-scramjet combustors is presented. Solutions for physical systems are dependent on empirical data bases from unit process experiments which include shock trains, jet penetration, and mixing. A synopsis of an experimental data base is presented and the method by which it is embodied in the analytical models is discussed. The models are then applied to develop design procedures for combustor-inlet isolators, discrete hole injectors, controlled shear layer mixing, and establishes the efficacy of sudden expansion steps for anchoring shock trains. Author

N91-23168# Toronto Univ., Downsview (Ontario). Inst. for Aerospace Studies.
PERFORMANCE CHARACTERISTICS OF HYPERSONIC DETONATION WAVE RAMJETS
T. M. ATAMANCHUK and J. P. SISLIAN *In* AGARD, Hypersonic Combined Cycle Propulsion 13 p Dec. 1990 Previously announced in IAA as A90-42188
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One method of heat addition to a supersonic flow is by means of shock-induced combustion or in this particular study a detonation wave. In order to assess the performance potential of a propulsion utilizing such a mode of heat addition a first order inviscid computational scheme based on Godunov's method was developed. This computational method was chosen since it allows the tracking of flow-field discontinuities such as shocks and slipstreams, thus making it possible to generate a vehicle geometry operating at design conditions for given freestream conditions. This same code was also used to determine the flow-field generated by a given body geometry at off-design conditions. Pressures acting

on these planar and axisymmetric bodies were calculated and used to determine various performance parameters over a range of Mach numbers. Two configurations consisting of multiple shock external and internal inlet compression, followed by an oblique Chapman-Jouguet detonation wave, were considered. Aerodynamic performance of planar multiple external shock inlet compression vehicles acting as lifting-propulsive bodies (integrated engine-airframe configurations) were also investigated. Off-design performance of these geometries was evaluated by varying the heat addition to the flow in order to obtain the desired thrust-to-dray ratio. For most body geometries operating at flight Mach numbers less than the design Mach number, it was found that no value of heat addition would maintain the design thrust-to-drag ratio. However, for flight Mach numbers greater than the design Mach number it was found that there usually existed at least two values, and in some cases three, of heat addition which would give the design thrust-to-drag ratio. Author

N91-23169*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ANALYTICAL AND EXPERIMENTAL INVESTIGATIONS OF THE OBLIQUE DETONATION WAVE ENGINE CONCEPT
GENE P. MENEES, HENRY G. ADELMAN, and JEAN-LUC CAMBIER (Eloret Corp., Moffett Field, CA.) *In* AGARD, Hypersonic Combined Cycle Propulsion 15 p Dec. 1990
Copyright Avail: NTIS HC/MF A20; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive CSCL 21/5

Wave combustors, which include the oblique detonation wave engine (ODWE), are attractive propulsion concepts for hypersonic flight. These engines utilize oblique shock or detonation waves to rapidly mix, ignite, and combust the air-fuel mixture in thin zones in the combustion chamber. Benefits of these combustion systems include shorter and lighter engines which require less cooling and can provide thrust at higher Mach numbers than conventional scramjets. The wave combustor's ability to operate at lower combustor inlet pressures may allow the vehicle to operate at lower dynamic pressures which could lessen the heating loads on the airframe. The research program at NASA-Ames includes analytical studies of the ODWE combustor using Computational Fluid Dynamics (CFD) codes which fully couple finite rate chemistry with fluid dynamics. In addition, experimental proof-of-concept studies are being performed in an arc heated hypersonic wind tunnel. Several fuel injection design were studied analytically and experimentally. In-stream strut fuel injectors were chosen to provide good mixing with minimal stagnation pressure losses. Measurements of flow field properties behind the oblique wave are compared to analytical predictions. Author

N91-23170# Prins Maurits Lab. TNO, Rijswijk (Netherlands).
THEORETICAL AND EXPERIMENTAL PERFORMANCE OF A SOLID FUEL RAMJET COMBUSTION CYCLE FOR HYPERSONIC FLIGHT CONDITIONS
P. J. M. ELANDS, P. A. O. G. KORTING, R. G. VERAAR, and P. DIJKSTRA (Technische Univ., Delft, Netherlands) *In* AGARD, Hypersonic Combined Cycle Propulsion 11 p Dec. 1990
Copyright Avail: NTIS HC/MF A20; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

A research program was performed to validate a numerical simulation of the flow and combustion process in the combustion chamber of a solid fuel ramjet with experimental results. Operating conditions were chosen to represent a sustained missile flight at Mach 4 at an altitude of 13 km. Experimental data were obtained by burning cylindrical fuel grains made of polyethylene and hydroxyl terminated polybutadiene in a solid fuel ramjet using a connected pipe facility. For numerical simulation a computer code was developed, describing rotational symmetric steady-state turbulent reacting flows through channels with and without a sudden expansion. Calculations were performed using polyethylene as a fuel. For the validation emphasis was laid on the regression rate. The results show that the computer code predicts the mean regression rate with reasonable accuracy. The value for the effective heat of gasification is found to be very important. The experiments and the calculations performed show the feasibility to apply a solid fuel ramjet for sustained hypersonic flight at these conditions. Author

N91-23176# Motoren- und Turbinen-Union Muenchen G.m.b.H. (Germany, F.R.).
THE 2-D SUPERSONIC NOZZLE DESIGN
MICHAEL GOEING and JOERG HEYSE *In* AGARD, Hypersonic Combined Cycle Propulsion 10 p Dec. 1990
Copyright Avail: NTIS HC/MF A20; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

A method based on the theory of characteristics is presented for two-dimensional, supersonic nozzle design. Individual nozzle configurations for different applications are obtained by combining the geometric attributes of the symmetric, single expansion ramp, and Prandtl-Meyer type expansion nozzles. Corresponding to the design criteria, such as minimum length and optimum thrust efficiency, relations between desired properties of the flow field and nozzle geometry parameters are found, and a family of length-optimized, two-dimensional, supersonic nozzles is defined. The method can be applied for the design of wind tunnel and steam turbine nozzles as well as for thrust nozzle design of high Mach number aircraft. Author

N91-23179*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
EFFECTS OF INLET DISTORTION ON THE DEVELOPMENT OF SECONDARY FLOWS IN A SUBSONIC AXIAL INLET COMPRESSOR ROTOR Ph.D. Thesis - Toledo Univ., OH
ALBERT K. OWEN Apr. 1991 340 p Prepared in cooperation with Army Aviation Systems Command, Cleveland, OH Original contains color illustrations
(Contract DA PROJ. 1L1-61102-AH-45)
(NASA-TM-104356; E-5583; NAS 1.15:104356;
AVSCOM-TR-90-C-012) Avail: NTIS HC/MF A15; 16 functional color pages CSCL 21/5

Detailed flow measurements were taken inside an isolated axial compressor rotor operating subsonically near peak efficiency. Laser anemometer measurements were made with two inlet velocity profiles. One profile consisted of an unmodified baseline flow, and the second profile was distorted by placing axisymmetric screens on the hub and shroud well upstream of the rotor. A primary flow is defined in the rotor and deviations from this primary flow for each inlet flow condition identified. A comparison between the two flow deviations is made to assess the development of a passage vortex due to the distortion of the inlet flow. A comparison of experimental results with computational predictions from a Navier-Stokes solver showed good agreement between predicted and measured flow. Measured results indicate that a distorted inlet profile has minimal effect on the development of the flow in the rotor passage and the resulting passage vortex. Author

N91-23180*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
MULTI-HEAT ADDITION TURBINE ENGINE Patent Application
LEO C. FRANCISCUS, inventor (to NASA) and THEODORE A. BRABBS, inventor (to NASA) (Sverdrup Technology, Inc., Brook Park, OH.) 30 Jan. 1991 12 p
(NASA-CASE-LEW-15094-1; NAS 1.71:LEW-15094-1;
US-PATENT-APPL-SN-647902) Avail: NTIS HC/MF A03 CSCL 21/5

A multi-heat addition turbine engine (MHATE) incorporates a plurality of heat addition devices to transfer energy to air and a plurality of turbines to extract energy from the air while converting it to work. The MHATE provides dry power and lower fuel consumption or lower combustor exit temperatures. NASA

N91-23182# National Aerospace Lab., Tokyo (Japan).
RESEARCH ON AERODYNAMIC CONTROL OF BLADE TIP CLEARANCE FLOW IN AIR-COOLED TURBINE
H. USUI, S. INOUE, M. MINODA, and H. NOSE May 1990 20 p In JAPANESE
(DE91-764223; NAL-TM-620) Avail: NTIS HC/MF A03

Nowadays, cooling measurements are being made of the increase in inlet temperature. In order to increase the gas turbine efficiency, it is necessary to take into consideration the influence of cooling air outlet, which cools the turbine blade, on the main flow. A newly designed rotating unit is used to test the aerodynamics of the air-cooled turbine. The influence of cooling the air outlet from the shroud ring at the moving blade tip on the performance was investigated. Also, the influence of the outlet angle, moving blade tip clearance, etc. were investigated. Some of the conclusions made from the results are as follows: (1) with increase in blade tip clearance, the flow rate at the turbine entrance almost uniformly increases at an arbitrary expansion ratio; (2) the thermal isolation efficiency, as defined by use of main flow only, uniformly increases at an arbitrary expansion ratio, in the case where cooling air exists; and (3) the thermal isolation efficiency, where cooling air is also regarded as an operating fluid, is equal regardless of whether or not cooling air exists, while the existence of the cooling air outlet produced a similar effect given the reduction in blade tip clearance. DOE

N91-23183*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ADVANCED ICE PROTECTION SYSTEMS TEST IN THE NASA LEWIS ICING RESEARCH TUNNEL
THOMAS H. BOND, JAIWON SHIN, and GEERT A. MESANDER (Oklahoma City Air Logistics Center, Tinker AFB, OK.) 1991 12 p Presented at the 47th Annual Forum and Technology Display, Phoenix, AZ, 6-8 May 1991; sponsored by American Helicopter Society
(NASA-TM-103757; E-6013; NAS 1.15:103757) Avail: NTIS HC/MF A03 CSCL 21/5

Tests of eight different deicing systems based on variations of three different technologies were conducted in the NASA Lewis Research Center Icing Research Tunnel (IRT) in June and July 1990. The systems used pneumatic, eddy current repulsive, and electro-expulsive means to shed ice. The tests were conducted on a 1.83 m span, 0.53 m chord NACA 0012 airfoil operated at a 4 degree angle of attack. The models were tested at two temperatures: a glaze condition at minus 3.9 C and a rime condition at minus 17.2 C. The systems were tested through a range of icing spray times and cycling rates. Characterization of the deicers was accomplished by monitoring power consumption, ice shed particle size, and residual ice. High speed video motion analysis was performed to quantify ice particle size. Author

N91-23184*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
MODEL ROTOR ICING TESTS IN THE NASA LEWIS ICING RESEARCH TUNNEL
ROBERT J. FLEMMING, RANDALL K. BRITTON (Sverdrup Technology, Inc., Brook Park, OH.), and THOMAS H. BOND 1991 27 p Presented at the 68th Meeting of the Fluid Dynamic Panel Specialists Meeting on the Effects of Adverse Weather on Aerodynamics, Toulouse, France, 29 Apr. - 1 May 1991; sponsored by AGARD
(NASA-TM-104351; E-6136; NAS 1.15:104351) Avail: NTIS HC/MF A03 CSCL 21/5

Tests of a lightly instrumented two-bladed teetering rotor and a heavily instrumented sub-scale articulated main rotor were conducted in the NASA Lewis Research Center Icing Research Tunnel (IRT) in August 1988 and September and November 1989. The first was an OH-58 tail rotor which had a diameter of 1.575 m and a blade chord of 0.133 m, and was mounted on a NASA designed test rig. The second, a four bladed articulated rotor, had a diameter of 1.83 m with 0.124 m chord blades specially fabricated for the experiment. This rotor was mounted on a Sikorsky Aircraft Powered Force Model, which enclosed a rotor balance and other measurement systems. The models were exposed to variations in temperature, liquid water content, and medium droplet diameter, and were operated over ranges of advance ratio, shaft angle, tip Mach number (rotor speed), and weight coefficient to determine the effect of these parameters on ice accretion. In addition to strain gage and balance data, the test was documented with still, video, and high speed photography, ice profile tracing, and ice molds. Presented here are the sensitivity of the model rotors to the test parameters and a comparison of the results to theoretical predictions. Author

N91-23185*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A CFD STUDY OF JET MIXING IN REDUCED FLOW AREAS FOR LOWER COMBUSTOR EMISSIONS
C. E. SMITH, M. V. TALPALLIKAR (CFD Research Corp., Huntsville, AL.), and J. D. HOLDEMAN 1991 17 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; sponsored by AIAA, SAE, ASME, and ASEE Original contains color illustrations
(Contract NAS3-25967)
(NASA-TM-104411; E-6238; NAS 1.15:104411; AIAA-91-2460)
Avail: NTIS HC/MF A03; 2 functional color pages CSCL 21/5

The Rich-burn/Quick-mix/Lean-burn (RQL) combustor has the potential of significantly reducing NO(x) emissions in combustion chambers of High Speed Civil Transport aircraft. Previous work on RQL combustors for industrial applications suggested the benefit of necking down the mixing section. A 3-D numerical investigation was performed to study the effects of neckdown on NO(x) emissions and to develop a correlation for optimum mixing designs in terms of neckdown area ratio. The results of the study showed that jet mixing in reduced flow areas does not enhance mixing, but does decrease residence time at high flame temperatures, thus reducing NO(x) formation. By necking down the mixing flow area by 4, a potential NO(x) reduction of 16:1 is possible for annual combustors. However, there is a penalty that accompanies the mixing neckdown: reduced pressure drop across the combustor swirler. At conventional combustor loading parameters, the pressure drop penalty does not appear to be excessive. Author

N91-23187# Aerospatiale, Toulouse (France).
INTEGRATION OF PROPULSIVE SYSTEMS: SELECTION AND COMPROMISE [INTEGRATION DES SYSTEMES PROPULSIFS: CHOIX ET COMPROMIS]
ALAIN GARCIA 1991 36 p In FRENCH Presented at AAF-ONERA Colloque Aeropropulsion, Paris, France, 20-21-May 1990
(REPT-911-111-101; ETN-91-99265) Avail: NTIS HC/MF A03

Emphasis is on a high percentage of dilute ion engines. It is shown that a solution allowing the best performances may be conflicting, particularly for the motor position in the plane, the safety, and the acoustic nuisances. Motor manufacturers have to consistently exchange their views, while taking into account their own interests, in order to reach the best compromise. Original solutions result from economic necessity. More and more performing design tools are being developed in order to meet with the requirements of program leaders. Computer aided design plays an important part in shape creation. Composite materials are widely used. Airborne computer operated jet engines are being introduced. It is shown that competition is a factor of progress, with the example of thrust inverters. Improvements were realized in the integration of high dilution engines, with regard to mass, fuel consumption, power plant drag and acoustic nuisance. ESA

N91-23188# Aerospatiale, Toulouse (France).
THE CERTIFICATION OF THE AIRCRAFT INTEGRATED PROPULSIVE SYSTEM [LA CERTIFICATION DU SYSTEME PROPULSIF INTEGRE SUR AVION]
PHILIPPE MARTIN and MARTINE SAINTE-MARIE 1991 35 p In FRENCH Presented at AAF-ONERA Colloque Aeropropulsion 90, Paris, France, 20-21 Mar. 1990
(REPT-911-111-102; ETN-91-99266) Avail: NTIS HC/MF A03

The propulsive system of an Airbus type aircraft is described. It includes the Full Authority Digital Electronic Control (FADEC) which is integrated with the aircraft, in order to realize the automatic control for thrust level, starting sequence, and thrust reversal sequence. The global certification process is presented, which includes the propulsive system certification. Airworthiness certification is given by the authorities for the aircraft. Differences

between engine and aircraft regulations are outlined for various aspects such as motor fatigue, composite materials, thunder, and electromagnetic radiation protection. Engine and aircraft regulations are sometimes interpreted differently for subjects like icing protection and motor bursting. It is concluded that a better harmonization of such regulations is desired, while maintaining present safety levels. ESA

N91-24201*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
STATIC PERFORMANCE TESTS OF A FLIGHT-TYPE STOVL EJECTOR
WENDY S. BARANKIEWICZ 1991 12 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; cosponsored by AIAA, SAE, ASME, and the American Society for Electrical Engineers
(NASA-TM-104437; E-6131; NAS 1.15:104437; AIAA-91-1902)
Avail: NTIS HC/MF A03 CSCL 21/5

The design and development of thrust augmenting STOVL ejectors has typically been based on experimental iteration (i.e., trial and error). Static performance tests of a full scale vertical lift ejector were performed at primary flow temperatures up to 1560 R (1100 F). Flow visualization (smoke generators and yarn tufts) were used to view the inlet air flow, especially around the primary nozzle and end plates. Performance calculations are presented for ambient temperatures close to 480 R (20 F) and 535 R (75 F) which simulate seasonal aircraft operating conditions. Resulting thrust augmentation ratios are presented as functions of nozzle pressure ratio and temperature. Author

N91-24202*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
MIXING OF MULTIPLE JETS WITH A CONFINED SUBSONIC CROSSFLOW. SUMMARY OF NASA-SUPPORTED EXPERIMENTS AND MODELING
JAMES D. HOLDEMAN 1991 49 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; sponsored by AIAA, SAE, ASME and the American Socienty for Electrical Engineers
(NASA-TM-104412; E-6239; NAS 1.15:104412; AIAA-91-2458)
Avail: NTIS HC/MF A03 CSCL 21/5

Experimental and computational results on the mixing of single, double, and opposed rows of jets with an isothermal or variable temperature mainstream in a confined subsonic crossflow are summarized. The studies were performed to investigate flow and geometric variations typical of the complex 3-D flowfield in the dilution zone of combustion chambers in gas turbine engines. The principal observations from the experiments were that the momentum-flux ratio was the most significant flow variable, and that temperature distributions were similar (independent of orifice diameter) when the orifice spacing and the square-root of the momentum-flux ratio were inversely proportional. The experiments and empirical model for the mixing of a single row of jets from round holes were extended to include several variations typical of gas turbine combustors. Combinations of flow and geometry that gave optimum mixing were identified from the experimental results. Based on results of calculations made with a 3-D numerical model, the empirical model was further extended to model the effects of curvature and convergence. The principle conclusions from this study were that the orifice spacing and momentum-flux relationships were the same as observed previously in a straight duct, but the jet structure was significantly different for jets injected from the inner wall wall of a turn than for those injected from the outer wall. Also, curvature in the axial direction caused a drift of the jet trajectories toward the inner wall, but the mixing in a turning and converging channel did not seem to be inhibited by the convergence, independent of whether the convergence was radial or circumferential. The calculated jet penetration and mixing in an annulus were similar to those in a rectangular duct when the orifice spacing was specified at the radius dividing the annulus into equal areas. Author

N91-24203*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FUEL-RICH, CATALYTIC REACTION EXPERIMENTAL RESULTS
R. JAMES ROLLBUHLER 1991 23 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; sponsored by AIAA, SAE, ASME, and the American Society for Electrical Engineers
(NASA-TM-104423; E-6256; NAS 1.15:104423; AIAA-91-2463)
Avail: NTIS HC/MF A03 CSCL 21/5

Future aeropropulsion gas turbine combustion requirements call for operating at very high inlet temperatures, pressures, and large temperature rises. At the same time, the combustion process is to have minimum pollution effects on the environment. Aircraft gas turbine engines utilize liquid hydrocarbon fuels which are difficult to uniformly atomize and mix with combustion air. An approach for minimizing fuel related problems is to transform the liquid fuel into gaseous form prior to the completion of the combustion process. Experimentally obtained results are presented for vaporizing and partially oxidizing a liquid hydrocarbon fuel into burnable gaseous components. The presented experimental data show that 1200 to 1300 K reaction product gas, rich in hydrogen, carbon monoxide, and light-end hydrocarbons, is formed when flowing 0.3 to 0.6 fuel to air mixes through a catalyst reactor. The reaction temperatures are kept low enough that nitrogen oxides and carbon particles (soot) do not form. Results are reported for tests using different catalyst types and configurations, mass flowrates, input temperatures, and fuel to air ratios. Author

N91-24204*# Avco Lycoming Div., Stratford, CT.
SMALL ENGINE COMPONENT TECHNOLOGY (SECT) STUDY. PROGRAM REPORT Final Report
E. ALMODOVAR, T. EXLEY, H. KAEHLER, and W. SCHNEIDER Mar. 1986 161 p
(Contract NAS3-24545; DA PROJ. 1L1-61101-AH-45)
(NASA-CR-175077; LYC-86-11; NAS 1.26:175077; AVSCOM-TR-86-C-12) Avail: NTIS HC/MF A08 CSCL 21/5

The study was conducted to identify high payoff technologies for year 2000 small gas turbine applications and to provide a technology plan for guiding future research and technology efforts. A regenerative cycle turboprop engine was selected for a 19 passenger commuter aircraft application. A series of engines incorporating eight levels of advanced technologies were studied and their impact on aircraft performance was evaluated. The study indicated a potential reduction in fuel burn of 38.3 percent. At $1.00 per gallon fuel price, a potential DOC benefit of 12.5 percent would be achieved. At $2.00 per gallon, the potential DOC benefit would increase to 17.0 percent. Four advanced technologies are recommended and appropriate research and technology programs were established to reach the year 2000 goals. Author

N91-24205*# Garrett Turbine Engine Co., Phoenix, AZ.
SMALL ENGINE COMPONENT TECHNOLOGY (SECT) Final Report
M. EARLY, R. DAWSON, P. ZEINER, M. TURK, and K. BENN Mar. 1986 470 p
(Contract NAS3-24544; DA PROJ. 1L1-61101-AH-45)
(NASA-CR-175078; NAS 1.26:175078; AVSCOM-TR-86-C-11; GARRETT-21-5776-2A) Avail: NTIS HC/MF A20 CSCL 21/5

A study of small gas turbine engines was conducted to identify high payoff technologies for year-2000 engines and to define companion technology plans. The study addressed engines in the 186 to 746 KW (250 to 1000 shp) or equivalent thrust range for rotorcraft, commuter (turboprop), cruise missile (turbojet), and APU applications. The results show that aggressive advancement of high payoff technologies can produce significant benefits, including reduced SFC, weight, and cost for year-2000 engines. Mission studies for these engines show potential fuel burn reductions of 22 to 71 percent. These engine benefits translate into reductions in rotorcraft and commuter aircraft direct operating costs (DOC) of 7 to 11 percent, and in APU-related DOCs of 37 to 47 percent. The study further shows that cruise missile range can be increased by as much as 200 percent (320 percent with slurry fuels) for a

year-2000 missile-turbojet system compared to a current rocket-powered system. The high payoff technologies were identified and the benefits quantified. Based on this, technology plans were defined for each of the four engine applications as recommended guidelines for further NASA research and technology efforts to establish technological readiness for the year 2000.
Author

N91-24206*# Williams International, Walled Lake, MI.
SMALL ENGINE COMPONENT TECHNOLOGY (SECT) STUDIES Final Report
P. K. MEYER and L. HARBOUR Mar. 1986 139 p
(Contract NAS3-24543; DA PROJ. 1L1-61101-AH-45)
(NASA-CR-175080; NAS 1.26:175080; AVSCOM-TR-86-C-9; FSCM-24235; REPT-074-021-M-005) Avail: NTIS HC/MF A07 CSCL 21/5

A study was conducted to identify component technology requirements for small, expendable gas turbine engines that would result in substantial improvements in performance and cost by the year 2000. A subsonic, 2600 nautical mile (4815 km) strategic cruise missile mission was selected for study. A baseline (state-of-the-art) engine and missile configuration were defined to evaluate the advanced technology engines. Two advanced technology engines were configured and evaluated using advanced component efficiencies and ceramic composite materials; a 22:1 overall pressure ratio, 3.85 bypass ratio twin-spool turbofan; and an 8:1 overall pressure, 3.66 bypass ratio, single-spool recuperated turbofan with 0.85 recuperator effectiveness. Results of mission analysis indicated a reduction in fuel burn of 38 and 47 percent compared to the baseline engine when using the advanced turbofan and recuperated turbofan, respectively. While use of either advanced engine resulted in approximately a 25 percent reduction in missile size, the unit life cycle (LCC) cost reduction of 56 percent for the advanced turbofan relative to the baseline engine gave it a decisive advantage over the recuperated turbofan with 47 percent LCC reduction. An additional range improvement of 10 percent results when using a 56 percent loaded carbon slurry fuel with either engine. These results can be realized only if significant progress is attained in the fields of solid lubricated bearings, small aerodynamic component performance, composite ceramic materials and integration of slurry fuels. A technology plan outlining prospective programs in these fields is presented. Author

N91-24207*# General Motors Corp., Indianapolis, IN. Allison Gas Turbine Div.
SMALL ENGINE COMPONENT TECHNOLOGY (SECT) STUDY Final Report
T. R. LARKIN Mar. 1986 156 p
(Contract NAS3-24542; DA PROJ. 1L1-61101-AH-45)
(NASA-CR-175081; EDR-12422; NAS 1.26:175081; AVSCOM-TR-86-C-8) Avail: NTIS HC/MF A08 CSCL 21/5

The objective of this study is to identify high payoff technologies for year 2000 small gas turbine engines, and to provide a technology plan to guide research and technology efforts toward revolutionizing the small gas turbine technology base. The goal is to define the required technology to provide a 30 percent reduction in mission fuel burned, to reduce direct operating costs by at least 10 percent, and to provide increased reliability and durability of the gas turbine propulsion system. The baseline established to evaluate the year 2000 technology base was an 8-passenger commercial tilt-rotor aircraft powered by a current technology gas turbine engine. Three basic engine cycles were studied: the simple cycle engine, a waste heat recovery cycle, and a wave rotor engine cycle. For the simple cycle engine, two general arrangements were considered: the traditional concentric spool arrangement and a nonconcentric spool arrangement. Both a regenerative and a recuperative cycle were studied for the waste heat recovery cycle. Author

N91-24208*# Teledyne CAE, Toledo, OH.
SMALL ENGINE COMPONENT TECHNOLOGY (SECT) STUDY Final Report
B. SINGH Mar. 1986 102 p Prepared for Army Aviation Systems Command, Cleveland, OH
(Contract NAS3-24541; DA PROJ. 1L1-61101-AH-45)
(NASA-CR-175079; NAS 1.26:175079; AVSCOM-TR-86-C-10; TELEDYNE-CAE-2224) Avail: NTIS HC/MF A06 CSCL 21/5

Small advanced (450 to 850 pounds thrust, 2002 to 3781 N) gas turbine engines were studied for a subsonic strategic cruise missile application, using projected year 2000 technology. An aircraft, mission characteristics, and baseline (state-of-the-art) engine were defined to evaluate technology benefits. Engine performance and configuration analyses were performed for two and three spool turbofan and propfan engine concepts. Mission and Life Cycle Cost (LCC) analyses were performed in which the candidate engines were compared to the baseline engines over a prescribed mission. The advanced technology engines reduced system LCC up to 41 percent relative to the baseline engine. Critical aerodynamic, materials, and mechanical systems turbine engine technologies were identified and program plans were defined for each identified critical technology. Author

N91-24292# Teledyne CAE, Toledo, OH.
MODEL 320-2: A COMPACT ADVANCED UAV TURBOJET
ELI H. BENSTEIN, BRIAN CASSEM, and KATHY ELLIOTT *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 p 285-294 Oct. 1990
Avail: NTIS HC/MF A20

The Model 320-2 is a 355 lb. thrust, outgrowth/up-rating of the family of small turbojets. It follows the thrust growth pattern of its predecessor J69 engines: a 40 percent increase is achieved by supercharging the simple centrifugal stage of the basic 320 turbojet with a high pressure ratio transonic axial stage, without change of engine diameter or core flowpath. The turbine was predesigned to allow for the increased work level without excessive efficiency loss. The engine retains the simple/low parts count design of the new family, which leads to very low production cost targets. Thus, for the intended expendable or limited life/reusable applications, a compact, high-performance, high-technology missile or unmanned air vehicle (UAV) powerplant results. The aerodynamic gas path is presented. The origins of the Model 320-2 is outlined, including its subsystems, the source for the down-scaled supercharging axial, and the approach to deletion of an inlet bleed valve at the 7.85:1 pressure ratio of the compressor. Engine test data are presented in comparison to model predictions, and projections are made for future directions for development.
Author

08

AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

A91-36358
STABILITY OF HINGELESS ROTORS IN HOVER USING THREE-DIMENSIONAL UNSTEADY AERODYNAMICS
OH J. KWON, DEWEY H. HODGES, and LAKSHMI N. SANKAR (Georgia Institute of Technology, Atlanta) American Helicopter Society, Journal (ISSN 0002-8711), vol. 36, April 1991, p. 21-31. refs
(Contract DAAG29-82-K-0094; DAAL03-88-C-0003)
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The effect of three-dimensional lifting surface aerodynamics on coupled flap-lag-torsion aeroelastic stability and response of two-bladed rotor models in the hovering flight conditions is analyzed using a three-dimensional unsteady panel method aerodynamic model coupled to a structural dynamic model of a hingeless rotor with elastic blades. For a simplified rotor, three-dimensional tip and realistic wake effects are found to have a nonnegligible effect on the steady equilibrium deflections. A correlation with experimental results demonstrates the improved capability of the

unsteady three-dimensional panel method aerodynamic model to predict the lead-lag damping of the two-bladed hingeless rotor model throughout the ranges of thrust, precone, droop, and pitch flexibility considered. V.L.

A91-36722#
THE INFLUENCE OF ALTITUDE AND SPEED VARIATIONS OVER THE AIRCRAFT FLIGHT CONTROL RESPONSE DURING THE LONGITUDINAL NONLINEAR MANOEUVRES
I. TAPOSU (Institutul National pentru Creatie Stiintifica si Tehnica, Bucharest, Rumania) Revue Roumaine des Sciences Techniques, Serie de Mecanique Appliquee (ISSN 0035-4074), vol. 35, July-Aug. 1990, p. 275-294. refs

The response of an aircraft to symmetrical deflection of flaps, elevators, and/or air brakes surfaces in longitudinal maneuvers with significant variations of altitude and speed is determined. The analysis is based on the nonlinear components of the aerodynamic and inertial loads established in the work of Taposu (1989). L.M.

A91-37051#
A NEW METHOD FOR ESTIMATING AIRSPEED, ATTACK ANGLE AND SIDESLIP ANGLE
REN DA (Northwestern Polytechnical University, Xian, People's Republic of China) and R. BROCKHAUS (Braunschweig, Technische Universitaet, Brunswick, Federal Republic of Germany) Northwestern Polytechnical University, Journal (ISSN 1000-2758), vol. 9, April 1991, p. 125-130. In Chinese, with abstract in English. refs

A nonlinear Kalman filter (NLKF) is presently used in place of a state observer in order to estimate aircraft airspeed, attack angle, and sideslip angle, on the basis of inertial navigation system information on aircraft rotation speed, attitude, and acceleration. A detailed analysis is conducted of NLKF errors by comparing simulated aircraft motions with NLKF estimates. NLKF performance is also compared with real flight test data. Airspeed estimation error is established to be less than 1 m/sec, while attack-angle and sideslip-angle estimation errors are of less than 1 deg. O.C.

A91-37595
DECOUPLED FLIGHT CONTROL VIA A MODEL-FOLLOWING TECHNIQUE USING THE EULER OPERATOR
PETER N. NIKIFORUK (Saskatchewan, University, Saskatoon, Canada), NORIYUKI HORI (McGill University, Montreal, Canada), and KIMIO KANAI (National Defense Academy, Yokosuka, Japan) IN: Control and dynamic systems. Vol. 33 - Advances in aerospace systems dynamics and control systems. Pt. 3. San Diego, CA, Academic Press, Inc., 1990, p. 59-87. refs
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The improved design of a model-following controller is described for the linear time-invariant MIMO case. Particular attention is given to a discrete-time system which is expressed in the Euler operator and which has the same number of points and outputs. An application of this model-following scheme to a CCV aircraft is considered and longitudinal motions are studied in detail. K.K.

A91-37597
METHODOLOGY FOR THE ANALYTICAL ASSESSMENT OF AIRCRAFT HANDLING QUALITIES
RONALD A. HESS (California, University, Davis) IN: Control and dynamic systems. Vol. 33 - Advances in aerospace systems dynamics and control systems. Pt. 3. San Diego, CA, Academic Press, Inc., 1990, p. 129-149. refs
Copyright

A theory for aircraft handling qualities is proposed and interpreted in terms of structural model of the human pilot. This methodology was developed based on the data from manned simulations involving 35 aircraft configurations in both single and multiloop tasks. It is noted that this methodology provides a framework within which to interpret the pilot's preference for an optimum control system sensitivity. K.K.

A91-37598* California Univ., Davis.
IDENTIFICATION OF PILOT-VEHICLE DYNAMICS FROM SIMULATION AND FLIGHT TEST
RONALD A. HESS (California, University, Davis) IN: Control and dynamic systems. Vol. 33 - Advances in aerospace systems dynamics and control systems. Pt. 3. San Diego, CA, Academic Press, Inc., 1990, p. 151-175. NASA-supported research. refs
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The paper discusses an identification problem in which a basic feedback control structure, or pilot control strategy, is hypothesized. Identification algorithms are employed to determine the particular form of pilot equalization in each feedback loop. It was found that both frequency- and time-domain identification techniques provide useful information. K.K.

A91-37771#
SIMPLIFICATION OF NONLINEAR INDICIAL RESPONSE MODELS - ASSESSMENT FOR THE TWO-DIMENSIONAL AIRFOIL CASE
JERRY E. JENKINS (USAF, Wright Research and Development Center, Wright-Patterson AFB, OH) Journal of Aircraft (ISSN 0021-8669), vol. 28, Feb. 1991, p. 131-138. USAF-supported research. Previously cited in issue 21, p. 3273, Accession no. A89-49056. refs

A91-37773#
EQUATION DECOUPLING - A NEW APPROACH TO THE AERODYNAMIC IDENTIFICATION OF UNSTABLE AIRCRAFT
HARALD PREISSLER and HORST SCHAEUFELE (MBB GmbH, Munich, Federal Republic of Germany) Journal of Aircraft (ISSN 0021-8669), vol. 28, Feb. 1991, p. 146-150. Previously cited in issue 14, p. 2135, Accession no. A90-33900. refs
Copyright

A91-37778#
RE-ENTRY FLIGHT CONTROL OF SPACE PLANE USING APPROXIMATE PERFECT SERVO
TADASHI SATO, TATSUO CHUBACHI (Iwate University, Morioka, Japan), SHOKICHI KANNO (Ichinoseki National College of Technology, Japan), and HIROBUMI OHTA (Nagoya University, Japan) Japan Society for Aeronautical and Space Sciences, Transactions (ISSN 0549-3811), vol. 33, Feb. 1991, p. 176-190. refs

The flight control system for reentry flight of a space plane is designed in this paper using the approximate perfect servo. The plane is sometimes almost unstable under the effect of shock wave. The term 'approximate perfect servo' means that the input/output transfer matrix is approximately equal to unit matrix. This system is effective to eliminate the effects of strong nonlinearity of angular velocity transformation matrix in the dynamics of three-dimensional motions of aircraft. The method is simple and easy to implement, and does not need any computation of aircraft dynamics. The designed system is robust and stable irrespective of the change of flight conditions and the variation of aircraft dynamics. Simulation studies on the reentry flight of space plane are given to substantiate the proposed method. Author

A91-37779#
IMPROVEMENT OF ATMOSPHERIC FLIGHT PERFORMANCE OF A SPACE VEHICLE THROUGH SENSITIVITY MINIMIZATION
YUKINOBU NAKAMURA (Nissan Motor Co., Ltd., Tokyo, Japan), MAKOTO KOBAYAKAWA (Kyoto University, Japan), and HIROYUKI IMAI (Setsunan University, Osaka, Japan) Japan Society for Aeronautical and Space Sciences, Transactions (ISSN 0549-3811), vol. 33, Feb. 1991, p. 191-203. refs

This paper considers the problem of improving controlled atmospheric flight performance of a winged space vehicle. The problem is shown to be formulated as an H(infinity)-sensitivity minimization problem. It is shown that if the weighting function satisfies a certain condition the optimization problem can be solved easily and the resulting optimal sensitivity function turns out to be proportional to the inverse of the weighting function. Through a

discussion on a geometric relationship between the sensitivity and the complementary sensitivity functions, a guideline is presented for choosing the weighting function. This guideline provides a good design tradeoff between those sensitivity functions only through sensitivity minimization. A numerical simulation is carried out for demonstrating the proposed method. Author

A91-38547# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
EFFECTS OF HORIZONTAL TAIL ICE ON LONGITUDINAL AERODYNAMIC DERIVATIVES
R. J. RANAUDO, A. L. REEHORST, T. H. BOND (NASA, Lewis Research Center, Cleveland, OH), J. G. BATTERSON (NASA, Langley Research Center, Hampton, VA), and T. M. O'MARA (George Washington University, Washington, DC) Journal of Aircraft (ISSN 0021-8669), vol. 28, March 1991, p. 193-199. Previously cited in issue 10, p. 1441, Accession no. A89-28454. refs
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A91-39401#
EVOLUTION OF AIRPLANE STABILITY AND CONTROL - A DESIGNER'S VIEWPOINT
JAN ROSKAM (Kansas, University, Lawrence) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, May-June 1991, p. 481-491. refs
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Stability and control developments affecting aircraft design are reviewed. The paper consists of three sections covering years before and through World War I, years between World War I and World War II, and years since World War II. The works of Draper, Combs, Cayley, Bryan, and other related to stability and control issues are highlighted, and emphasis is placed on Routh's stability criteria. The effect of lateral and directional stability on the dynamic stability behavior is discussed, and examples of control-surface, tab, and bob-weight applications are presented. The effects of configuration on the fuselage-induced shift of the aerodynamic center, and aeroelasticity and wheel-control force on roll performance are outlined. Roll coupling stability boundaries, the equivalent stability derivative concept, and the pitch break behavior as a function of the horizontal tail location are covered. V.T.

A91-39410#
INTEGRATION OF FOUR-DIMENSIONAL GUIDANCE WITH TOTAL ENERGY CONTROL SYSTEM
ISAAC KAMINER and PATRICK O'SHAUGHNESSY (Boeing Co., Seattle, WA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, May-June 1991, p. 564-573. Previously cited in issue 21, p. 3492, Accession no. A88-50177. refs
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A91-40133#
THE DESIGN AND SIMULATION OF AN INTELLIGENT FLIGHT CONTROL SYSTEM
CHANGSHENG JIANG and ZHONGHAN HU (Nanjing Aeronautical Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, Jan. 1991, p. A46-A53. In Chinese, with abstract in English. refs
The design of an intelligence automatic flight control system is discussed. The basic structure of the system, the basic rule of intelligence control for simulating human behavior, the division of a characteristic model, and the construction of intelligence control laws are suggested. Based on the principles mentioned above, the knowledge base, the data base, the rule base, and inference mechanism of the system are designed. It is demonstrated by digital simulation for some kinds of aircraft that this system has excellent control performance, strong robustness and adaptability, and good decoupling function. Author

A91-40164#
FURTHER RESEARCH ON MECHANICAL MODEL FOR 'GROUND RESONANCE' OF HELICOPTERS
ZHONGGUAN GU and ZHONG LI (Nanjing Aeronautical Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 11, Nov. 1990, p. A605-A611. In Chinese, with abstract in English.
The equations of vibrational motion for a helicopter on the ground are derived, employing a three-dimensional model in which the rotors have two degrees of freedom and the landing-gear response is frequency-dependent. The steps in the analysis are described in detail, and sample numerical calculations demonstrating the validity of the approach are presented in tables and graphs. D.G.

A91-40166#
SIMILARITIES AND DIFFERENCES BETWEEN ENVIRONMENT TESTS AND RELIABILITY TESTS IN VIEW OF VIBRATION
QINGXIANG GONG (Nanchang Aircraft Manufacturing Co., People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 11, Nov. 1990, p. A615-A617. In Chinese, with abstract in English.
The relationship between aircraft environmental vibration tests and reliability test is examined theoretically, considering the procedures called for by military standards 810D and 781D (1982 and 1986). Particular attention is given to such factors as the test aims, the testing situations, the test duration, and the failure criteria applied. D.G.

A91-40167#
APPLICATION OF IDENTIFICATION METHOD OF MODAL PARAMETERS TO FLIGHT FLUTTER TEST
JIANZHONG QU and CHANGAN SHA (China Academy of Flight Test, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 11, Nov. 1990, p. A618-A622. In Chinese, with abstract in English.
The mathematical basis of a technique for processing flutter data from aircraft flight tests is outlined. Frequency-domain and time-domain approaches to the identification of modal frequency and damping parameters are described, and procedures are developed (1) to eliminate the negative effects of low signal/noise ratios and (2) shorten the computation time. D.G.

A91-40168#
INTEGRATION OF VIBRATION TEST AND FLUTTER ANALYSIS - A BRIEF INTRODUCTION TO 'A REAL-TIME FLUTTER ANALYSIS SYSTEM'
PIQIAN QI, ZUDE GE, BINGGONG LI, and GUANGQI XU (Aircraft Structure Strength Research Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 11, Nov. 1990, p. A623-A625. In Chinese, with abstract in English. refs
The theoretical basis and implementation of an algorithm for aircraft flutter analysis on the basis of data from ground vibration tests are briefly discussed. The flutter analysis takes two different approaches, one involving direct application of the (orthogonalized) mode vectors and one based on the use of test data to improve the aircraft dynamic model. Also outlined is an inverse branch-mode-synthesis scheme to facilitate the modification of aircraft substructures. D.G.

A91-40169#
TRANSONIC FLUTTER ANALYSIS OF 2-D AIRFOILS WITH 2 DEGREES OF FREEDOM
YUFENG YAO (Shanghai Aircraft Design and Research Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 11, Nov. 1990, p. A626-A629. In Chinese, with abstract in English.
A numerical solution procedure for two-dimensional inviscid nonlinear unsteady transonic flows is developed analytically under the small-disturbance assumption and applied to the flutter analysis of a NACA 64A006 airfoil with pitching and plunging degrees of freedom. The flow equations are split into nonlinear steady and time-linearized unsteady parts and solved by the Carlson and integral methods, respectively, and the flutter eigenvalue equations are treated using a conventional v-g approach. Flutter speeds

and flutter-reduced frequencies are calculated for Mach 0.7, 0.8, and 0.85 and presented in tables; good agreement with the results of Yang et al. (1978) is demonstrated. D.G.

A91-40175#
PREDICTION OF TEST SPECTRUM FOR GUNFIRE VIBRATION
BAOLU WANG (Chengdu Aircraft Co., People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 11, Nov. 1990, p. A650-A652. In Chinese, with abstract in English.

A numerical technique for estimating the spectrum of aircraft vibration induced by the firing of guns is briefly described. The derivation of the governing equations is outlined; typical parameter values are indicated; and sample results are presented in graphs. D.G.

A91-40202
TESTING THE TILTROTOR FLIGHT CONTROL SYSTEM
Aerospace Engineering (ISSN 0736-2536), vol. 11, June 1991, p. 37-40.
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A review is presented of the V-22 tiltrotor's fly-by-wire digital flight control system (FCS) and the test system used, beginning at the lowest possible level, and again at each succeeding level, until the complete system is assembled on the aircraft for first flight. Extensive verification testing was performed on the FCS software to ensure that it operates in accordance with the detailed functional requirements established in the program performance specification for each computer program. The primary reason for validating the FCS was to successfully integrate the separate pieces of hardware (hydraulic components, computers, sensors, electrical system) into a fully functional whole. Additional details are provided for testing performed on the specific systems. R.E.P.

A91-40517#
FLIGHT MANAGEMENT SYSTEMS
SAMUEL B. FISHBEIN Washington, DC, National Air and Space Museum, 1990, 67 p. refs

A historical overview is presented of aviation electronics and instrumentation, the evolution to automated systems and their integration, and the role of the pilot in this environment. Also reviewed are the major instrumented elements comprising the flight management system and their evolution and operation. Attention is given to those ground and space-based systems influencing the design of the airborne systems and discusses the digitization of information and its influence over the design of the cockpit configuration. R.E.P.

N91-23113# British Aerospace Public Ltd. Co., Preston (England). Military Aircraft Div.
THE DEVELOPMENT OF ALTERNATE CRITERIA FOR FBW HANDLING QUALITIES
J. C. GIBSON *In* AGARD, Flying Qualities 13 p Feb. 1991
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Provision of robust flight control systems and structural mode stability margins and carefree handling in highly unstable combat aircraft with a wide range of store loading requires new methods for handling qualities optimization. The possibilities for new control modes and task-tailored handling were greatly enhanced by modern controls. This has led to development of many alternate criteria which were tried and tested in two digital fly by wire (FBW) research aircraft, the Experimental Aircraft Program (EAP) and Jaguar FBW, and were further developed for use in European fighter aircraft (EFA). They cover the field of flight path and attitude bandwidth, tracking dynamics and sensitivity, pilot-induced oscillation (PIO) prevention, and enhanced lateral directional damping. Derived as design guidelines with the facility to design for optimum rather than merely acceptable handling, more research is needed into formal boundaries for levels 1, 2, and 3 specifications. The criteria are reviewed and some are illustrated by example. Author

N91-23114# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.). Inst. fuer Flugmechanik.
DEVELOPMENT OF MIL-8785C INTO A HANDLING QUALITIES SPECIFICATION FOR A NEW EUROPEAN FIGHTER AIRCRAFT
E. BUCHACKER, H. GALLEITHNER, R. KOEHLER, and M. MARCHAND *In* AGARD, Flying Qualities 16 p Feb. 1991
Copyright Avail: NTIS HC/MF A17; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

For the development of the Tornado, which started in the sixties, a draft version of MIL 8785B was used as a guideline and specification for the flying qualities the airplane should have. No consideration was given at that time to the fact that requirements, which were based on mathematical models of the airplane, only considered the flight mechanics of the bare airframe. In most cases, a new airplane is sold on performance promises. The fact that a pilot has to be able to fly an airplane safely and efficiently in order to achieve full performance, especially in a combat airplane, is often forgotten. The Armed Forces are repeatedly disappointed with their aircraft when it becomes clear that it is impossible to achieve the promised performance for reasons of conflicting flying qualities issues which demand other than performance optimal trim schedules. This, coupled with the fact that there was not a lot of flying qualities research within the nations participating in the Tornado program, led to the situation that it is was more or less only during flight tests that the user realized the problems involved with full authority full time flight control systems. In the meantime, however, some research efforts have been initiated by government and industry that have provided some second thoughts on flying qualities requirements for highly augmented airplanes with a basically unstable pitch axis. Together with industry, the four nations involved in the European Fighter Aircraft (EFA) Program decided to initiate an effort to generate a flying qualities specification for EFA based on the MIL-F-8785C. Some of the issues discussed include the following: the equivalent system approach, high order requirements for the pitch axis, the carefree handling issue, roll performance, small lateral directional inputs, air combat, and stall and spin. Author

N91-23116# Dornier System G.m.b.H., Friedrichshafen (Germany, F.R.).
HANDLING QUALITIES OF HIGHLY AUGMENTED UNSTABLE AIRCRAFT SUMMARY OF AN AGARD-FMP WORKING GROUP EFFORT
HORST WUENNENBERG *In* AGARD, Flying Qualities 6 p Feb. 1991
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Methods and criteria which were found to be useful as design guides and for the evaluation of handling qualities of highly augmented aircraft are presented. It was the unanimous opinion of the members of the working group that no one method or criterion is adequate by itself, and that several or even all of the recommended criteria should be checked. Experience has shown that one metric may not show a deficiency that will be exposed by other criteria. Alternately, a configuration that passes several of the proposed criteria has a high probability of being accepted as desirable by most pilots. The major topics covered by the working group's report are listed. Author

N91-23117# Wright Research Development Center, Wright-Patterson AFB, OH.
THE HANDLING QUALITIES OF THE STOL AND MANEUVER TECHNOLOGY DEMONSTRATOR FROM SPECIFICATION TO FLIGHT TEST
DAVID J. MOORHOUSE, KEVIN D. CITURS, RICHARD W. THOMAS, and MARK R. CRAWFORD (Air Force Flight Test Center, Edwards AFB, CA.) *In* AGARD, Flying Qualities 9 p Feb. 1991
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The STOL and Maneuver Technology Demonstrator (S/MTD) development from the initial specification through current flight

test results is discussed. Lessons learned with respect to individual specification criteria and design methodology are presented. Two areas are identified in which it is considered that the current criteria are inadequate: pitch axis requirements as a function of touchdown dispersion and the directional axis requirement for target tracking.
Author

N91-23119# Royal Aerospace Establishment, Bedford (England).
HANDLING QUALITIES GUIDELINES FOR THE DESIGN OF FLY-BY-WIRE FLIGHT CONTROL SYSTEMS FOR TRANSPORT AIRCRAFT
O. P. NICHOLAS, H. T. HUYNH, W. P. DEBOER, J. A. J. VANENGELEN, and D. SHAFRANEK (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick, Germany, F.R.) *In* AGARD, Flying Qualities 12 p Feb. 1991
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The work of the GARTEUR Flight Mechanics Action Group 01 is summarized. The objectives, which concentrated on longitudinal control, are outlined. The flight control systems and the simulator trials are discussed. Existing handling qualities criteria and the Action Group's tentative proposals for handling qualities measures which can be applied to flight path control and system changeover are assessed. Finally, the Group's guidelines and recommendations for further work are reviewed.
Author

N91-23123# National Aeronautical Establishment, Ottawa (Ontario). Flight Research Lab.
AN INVESTIGATION INTO THE USE OF SIDE-ARM CONTROL FOR CIVIL ROTORCRAFT APPLICATIONS
S. W. BAILLIE and S. KERELIUK *In* AGARD, Flying Qualities 12 p Feb. 1991 Prepared in cooperation with FAA, Atlantic City, NJ
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An evaluation of the handling qualities of civil rotorcraft incorporating force or displacement sensing side-arm controllers with varying degrees of control integration was carried out on the NAE Bell 205 Airborne Simulator. Evaluators were certification pilots from the FAA and Transport Canada. The results indicate that integrated 4-axis side-arm control is a viable option for civil rotorcraft operations, even when used in conjunction with very low levels of stability and control augmentation.
Author

N91-23124# National Aeronautical Establishment, Ottawa (Ontario).
DETERMINATION OF DECISION-HEIGHT WINDOWS FOR DECELERATING IMC APPROACHES IN HELICOPTERS
ROGER H. HOH (Hoh Aeronautics, Inc., Lomita, CA.), S. W. BAILLIE, S. KERELIUK, and JOSEPH J. TRAYBAR *In* AGARD, Flying, Qualities 17 p Feb. 1991 Prepared in cooperation with Federal Aviation Administration, Atlantic City, NJ
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The basic limitations were defined of the pilot plus rotorcraft in making the transition from a very low decision height to a steady hover over the helipad. The term 'decision-height window' is defined as the limits of glideslope/localizer tracking errors, and groundspeed variations, that can exist at breakout to allow a safe visual transition to hover. The dimensions of the decision-height window can have a significant impact on the required rotorcraft handling qualities, and for setting autopilot coupler and flight director performance standards for decelerating instrument approaches in rotorcraft.
Author

N91-23125# Dornier System G.m.b.H., Friedrichshafen (Germany, F.R.).
INTEGRATION OF HANDLING QUALITY ASPECTS INTO THE AERODYNAMIC DESIGN OF MODERN UNSTABLE FIGHTERS
PETER MANGOLD *In* AGARD, Flying Qualities 30 p Feb. 1991
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The following subject areas are covered: flightmechanical design of unaugmented stable configurations; design criteria for modern configurations with unstable characteristics in pitch; development of specific criteria for modern fighter configurations; and aerodynamic/flightmechanical pecularities of configurations.
Author

N91-23190 California Univ., Los Angeles.
INTEGRATED MULTIDISCIPLINARY OPTIMIZATION OF ACTIVELY CONTROLLED FIBER COMPOSITE WINGS Ph.D. Thesis
ELIEZER LIVNE 1990 432 p
Avail: Univ. Microfilms Order No. DA9105834

The synthesis of actively controlled fiber composite wings is formulated as a multidisciplinary design optimization problem. An integration of analysis techniques spanning the disciplines of structures, aerodynamics, and controls is described. A rich variety of behavior constraints can be treated including stress, displacement, control surface travel and hinge moment, natural frequency, aeroservoelastic stability, gust response, and handling quality constraints as well as performance measures in terms of drag/lift coefficients, drag polar shape, required load factor on roll rate, and wing mass. The design space includes a simultaneous treatment of structural, aerodynamic, and control system design variables. Capabilities and accuracy of the analysis and related behavior sensitivity analysis are discussed. Applicability of approximation concepts to the multidisciplinary optimization problem is examined by studying typical aeroservoelastic stability, gust response, and performance related constraints. The high computational efficiency of the combined analysis and sensitivity as well as the good quality of key behavior constraint approximations set the stage for the optimization of actively controlled fiber composite wings in a practical preliminary design context. Design studies of different wing configurations demonstrate the power of the new technology and offer better understanding of the multidisciplinary interactions inherent to this complex problem.
Author

N91-23191# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.). Abt. Flaechenflugzeuge.
EVALUATION TECHNIQUES FOR HIGHLY AUGMENTED AIRCRAFT
KNUT WILHELM and ANTON M. H. NIEUWPOORT (Fokker B.V., Schipol-Oost, Netherlands) Nov. 1990 51 p
(DLR-FB-90-35; ISSN-0939-2963; ETN-91-99063) Avail: NTIS HC/MF A04; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 20.50 DM

The handling qualities evaluation is a very important part of the overall flight control system development process. For determining the flight characteristics of highly augmented aircraft there are basically two methods: evaluation using pilots under operational conditions and numerical handling qualities evaluation using mathematical models of the aircraft. Both methods are addressed with main emphasis laid on those techniques suitable for handling qualities analysis of highly augmented aircraft. The important role of system identification in the handling qualities evaluation process is presented.
ESA

N91-23192# Aerospatiale, Toulouse (France).
THE ELECTRICAL FLIGHT CONTROL SYSTEM OF A320 AIRBUS: A FAULT TOLERANT SYSTEM [LES COMMANDES DE VOL ELECTRIQUES DE L'AIRBUS A320: UN SYSTEME TOLERANT AUX FAUTES]
DOMINIQUE BRIERE and PASCAL TRAVERSE 1991 6 p In FRENCH; ENGLISH summary Presented at 7th International Conference on Reliability and Maintenance, Brest, France, 1990
(REPT-911-111-103; ETN-91-99267) Avail: NTIS HC/MF A02

The A 320 Airbus is the first civil aircraft equipped with an electrical flight control system. This system is based on very stringent dependability constraints, both in terms of safety and

availability. The basic building blocks are control and monitoring computers. The control channel is in charge of the function of the computer, for instance, to slave a control surface. The monitoring channel is used to detect a possible failure of the control channel. A high level of redundancy is built in the system. Particular attention is drawn to possible external stresses. The system is built to tolerate both hardware and software design faults. ESA

N91-24209*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SIMULATION EVALUATION OF A SPEED-GUIDANCE LAW FOR HARRIER APPROACH TRANSITIONS
VERNON K. MERRICK, ERNESTO MORALEZ, MICHAEL W. STORTZ, GORDON H. HARDY, and RONALD M. GERDES (SYRE Corp., Moffett Field, CA.) Apr. 1991 34 p
(NASA-TM-102853; A-90247; NAS 1.15:102853) Avail: NTIS HC/MF A03 CSCL 01/3

An exponential-deceleration speed guidance law is formulated which mimics the technique currently used by Harrier pilots to perform decelerating approaches to a hover. This guidance law was tested along with an existing two-step constant deceleration speed guidance law, using a fixed-base piloted simulator programmed to represent a YAV-8B Harrier. Decelerating approaches to a hover at a predetermined station-keeping point were performed along a straight (-3 deg glideslope) path in headwinds up to 40 knots and turbulence up to 6 ft./sec. Visibility was fixed at one-quarter nautical mile and 100 ft. cloud ceiling. Three Harrier pilots participated in the experiment. Handling qualities with the aircraft equipped with the standard YAV-8B rate damped attitude stability augmentation system were adequate (level 2) using either speed guidance law. However, the exponential deceleration speed guidance law was rated superior to the constant-deceleration speed guidance law by a Cooper-Harper handling qualities rating of about one unit independent of the level of wind and turbulence. Replacing the attitude control system of the YAV-8B with a high fidelity model following attitude flight controller increased the approach accuracy and reduced the pilot workload. With one minor exception, the handling qualities for the approach were rated satisfactory (level 1). It is concluded that the exponential deceleration speed guidance law is the most cost effective. Author

N91-24210*# Sparta, Inc., Laguna Hills, CA.
NATIONAL REMOTE COMPUTATIONAL FLIGHT RESEARCH FACILITY
HERMAN A. REDIESS Sep. 1989 85 p
(Contract NAS2-12211)
(NASA-CR-179432; H-1489; NAS 1.26:179432) Avail: NTIS HC/MF A05 CSCL 01/3

The extension of the NASA Ames-Dryden remotely augmented vehicle (RAV) facility to accommodate flight testing of a hypersonic aircraft utilizing the continental United States as a test range is investigated. The development and demonstration of an automated flight test management system (ATMS) that uses expert system technology for flight test planning, scheduling, and execution is documented. Author

09

RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

A91-37775#
ONE-ON-ONE HELICOPTER COMBAT SIMULATED BY CHESS-TYPE LOOKAHEAD
AMNON KATZ and ARTHUR ROSS (McDonnell Douglas Helicopter Co., Mesa, AZ) Journal of Aircraft (ISSN 0021-8669), vol. 28, Feb. 1991, p. 158-160. Previously cited in issue 21, p. 3279, Accession no. A89-48421. refs
Copyright

A91-37881#
DEVELOPMENT OF B-1 ANTENNA MEASUREMENT TEST BED
SIGMUND S. GRUDZINSKI (USAF, Rome Air Development Center, Griffiss AFB, NY) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985), vol. 6, April 1991, p. 7-11.

The establishment of a B-1 test bed is chronicled from identification of the requirement to the initial measurements program. Disassembly, modification, and reassembly of the airframe are covered. Future modifications and measurements are previewed. The facilities at which the B-1 test bed is located are briefly discussed. I.E.

A91-39396
SIMULATION OF G(X) FORCES USING HORIZONTAL IMPULSE ACCELERATORS
RICHARD P. WHITE, JR. and MARTIN G. VOGEL (Systems Research Laboratories, Inc., Dayton, OH) IN: Annual SAFE Symposium, 27th, New Orleans, LA, Dec. 5-8, 1989, Proceedings. Newhall, CA, SAFE Association, 1990, p. 195-201.
Copyright

The success achieved in the development of effective ejections systems is attested by the number of lives these systems have saved. During the development of these life-saving systems, many tests are conducted on the subsystems to ensure their adequacy of performance in the dynamic environment associated with a high speed ejection. The dynamic loadings which the systems are designed to resist are generally based on the limits on the human body. The establishment of these human limits has been gained from data obtained during tests conducted on humans up to safe G(x) levels and by the use of human analogs at the G(x) levels that are anticipated during high speed ejections. Analysis of these data, in association with physiological data of the human body, has led to a set of guidelines that is used to design the dynamic and structural characteristics of ejection seats and the restraint system. Author

A91-40556#
AN INTRODUCTION TO TESTING PARACHUTES IN WIND TUNNELS
J. M. MACHA (Sandia National Laboratories, Albuquerque, NM) AIAA, Aerodynamic Decelerator Systems Technology Conference, 11th, San Diego, CA, Apr. 9-11, 1991. 11 p. refs
(Contract DE-AC04-76DP-00789)
(AIAA PAPER 91-0858)

This paper reviews some of the technical considerations and current practices for testing parachutes in conventional wind tunnels. Special challenges to the experimentalist caused by the fabric construction, flexible geometry, and bluff shape of parachutes are discussed. In particular, the topics of measurement technique, similarity considerations, and wall interference are addressed in a summary manner. Many references are cited which provide detailed coverage of the state of the art in testing methods. Author

N91-23194# Israel Aircraft Industries Ltd., Ben-Gurion Airport. Materials and Process Engineering.
IAI HYPERSONIC WIND TUNNEL
L. Y. JACOBI and M. ZILBERMAN May 1987 18 p Presented at the 67th Semiannual STA Meeting, Arnold AFS, TN, 13-15 Apr. 1987; sponsored by Calspan Corp./AEDC Div.
(IAITIC-87-1006; ITN-88-85005) Avail: NTIS HC/MF A03

IAI (Israel Aircraft Industries) has initiated a program to have its own capability in experimental hypersonic aerodynamics. It is planning to reconstruct and operate the Hypersonic Wind Tunnel, purchased in 1978 from General Dynamics, together with its Tri-sonic Wind Tunnel to complement its Low Speed and High Speed Wind Tunnels. The air supply system, air heater, by-pass valve, nozzles, test chamber and diffuser-ejector system of the Hypersonic Wind Tunnel are described and its operational

characteristics and experience presented. The purpose of the presentation is to invite participants' suggestions for future development of hypersonic vehicles. ISA

N91-23195*# MCAT Inst., San Jose, CA.
DEVELOPMENT OF A QUIET SUPERSONIC WIND TUNNEL WITH A CRYOGENIC ADAPTIVE NOZZLE Annual Progress Report, May 1990 - Apr. 1991
STEPHEN D. WOLF Feb. 1991 106 p
(Contract NCC2-604)
(NASA-CR-186769; NAS 1.26:186769) Avail: NTIS HC/MF A06
CSCL 14/2

The main objectives of this work is to demonstrate the potential of a cryogenic adaptive nozzle to generate quiet (low disturbance) supersonic flow. A drive system was researched for the Fluid Mechanics Laboratory (FML) Laminar Flow Supersonic Wind Tunnel (LFSWT) using a pilot tunnel. A supportive effort for ongoing Proof of Concept (PoC) research leading to the design of critical components of the LFSWT was maintained. The state-of-the-art in quiet supersonic wind tunnel design was investigated. A supersonic research capability was developed within the FML.
Author

N91-23198# Federal Aviation Administration, Washington, DC. Systems Research and Development Service.
PRECISION RUNWAY MONITOR DEMONSTRATION REPORT Final Report
Feb. 1991 133 p
(AD-A232671; DOT/FAA/RD-91/5) Avail: NTIS HC/MF A07
CSCL 01/5

This report is prepared as the result of a development and demonstration project to increase landing capacity on closely spaced parallel runways. The project developed new equipment and procedures, and demonstrated them in a variety of ways at two different airports. The new monitoring equipment consists of radars and displays. The systems installed at Raleigh, NC included an electronically scanned antenna capable of half-second update intervals, while the Memphis, TN installation provided a mechanically rotating back-to-back antenna with a 2.4-second update interval. In addition, both sites provided enhanced high-resolution color ATC display systems. The purpose of the report is to present findings relevant to a decision concerning whether or not the current standard for runway separation of 4,300 ft can be reduced to 3,400 ft when the precision runway monitor equipment is utilized. The 3,400-ft separation was the spacing demonstrated most often in both simulations and flight tests. The demonstration produced a broad recognition that both systems could be used to monitor parallel runways spaced at 3400 feet apart. GRA

N91-23199# Army Engineer Waterways Experiment Station, Vicksburg, MS. Geotechnical Lab.
LITERATURE REVIEW ON GEOTEXTILES TO IMPROVE PAVEMENTS FOR GENERAL AVIATION AIRPORTS Final Report
DEWEY W. WHITE, JR. Feb. 1991 61 p
(AD-A232871; WES/MP/GL-91-3) Avail: NTIS HC/MF A04
CSCL 13/2

This report covers a literature search and review to obtain information on geotextile applications related to pavement construction. Applicable information from this study would be used to prepare guidelines on design application, material specifications, performance criteria, and construction procedures for improving subgrade support with geotextiles in general aviation airport pavements. The study revealed that there are numerous design procedures available for using geotextiles in aggregate surfaced pavements and flexible pavement road construction. However, there is no generally accepted procedure for either type construction. The state-of-the-art has not advanced to the point where design procedures for using geotextiles in paved airport construction are available. Construction/installation procedures are available for using geotextiles in aggregate surfaced pavements and flexible pavements for roads, and these may be used as an aid in recommending procedures for airport construction. GRA

N91-24133*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NATIONAL TRANSONIC FACILITY STATUS
L. W. MCKINNEY, W. E. BRUCE, JR., and B. B. GLOSS *In its* Transonic Symposium: Theory, Application and Experiment, Volume 2 p 1-39 Apr. 1989
Avail: NTIS HC/MF A11 CSCL 14/2

The National Transonic Facility (NTF) was operational in a combined checkout and test mode for about 3 years. During this time there were many challenges associated with movement of mechanical components, operation of instrumentation systems, and drying of insulation in the cryogenic environment. Most of these challenges were met to date along with completion of a basic flow calibration and aerodynamic tests of a number of configurations. Some of the major challenges resulting from cryogenic environment are reviewed with regard to hardware systems and data quality. Reynolds number effects on several configurations are also discussed. Author

N91-24211*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ADVANCED HYPERVELOCITY AEROPHYSICS FACILITY WORKSHOP
ROBERT D. WITCOFSKI, comp. and WILLIAM I. SCALLION, comp. May 1989 170 p Workshop held in Hampton, VA, 10-11 May 1988
(NASA-CP-10031; NAS 1.55:10031) Avail: NTIS HC/MF A08
CSCL 14/2

The primary objective of the workshop was to obtain a critical assessment of a concept for a large, advanced hypervelocity ballistic range test facility powered by an electromagnetic launcher, which was proposed by the Langley Research Center. It was concluded that the subject large-scale facility was feasible and would provide the required ground-based capability for performing tests at entry flight conditions (velocity and density) on large, complex, instrumented models. It was also concluded that advances in remote measurement techniques and particularly onboard model instrumentation, light-weight model construction techniques, and model electromagnetic launcher (EML) systems must be made before any commitment for the construction of such a facility can be made. Author

10

ASTRONAUTICS

Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

A91-36625
ACCENT ON HYPERSONIC
GILBERT SEDBON Flight International (ISSN 0015-3710), vol. 139, April 23, 1991, p. 28-30.
Copyright

A review is presented of research and development being conducted by France in the field of hypersonic propulsion. Current studies are involved in building a database on aerodynamics, engine/airframe integration, stage separation, composite materials and structures. Consideration is given to different engine propulsion concepts, including turborocket-ramjet, turboexpander-ramjet, turbofan-ramjet, turbo-ramjet, rocket-ramjet, liquid air rocket, cooled air rocket, and supersonic-combustion ramjet. Economic benefits, technological spin-offs, and possible multinational cooperation are discussed. R.E.P.

A91-40555#
A DYNAMIC ANALYSIS OF THE SRB PARACHUTE SYSTEM
D. F. WOLF (Sandia National Laboratories, Albuquerque, NM) AIAA, Aerodynamic Decelerator Systems Technology Conference, 11th, San Diego, CA, Apr. 9-11, 1991. 9 p. refs
(AIAA PAPER 91-0838) Copyright

A computer-aided dynamic analysis of a parachute and payload system is described which models an arbitrary number of individual parachutes in the cluster and their combined effects on the motion of the attached payload. The three-dimensional motions of the parachute and payload system are displayed using computer generated drawings of the objects. Photographs and simulated motion drawings are presented for the two-body SRB and drogue parachute and the four-body SRB and main parachute cluster systems. Author

N91-24289# Wright Research Development Center, Wright-Patterson AFB, OH.
AN EXPERIMENTAL EVALUATION OF COMBUSTOR LINER MATERIALS FOR SOLID FUEL RAMJET TESTING
J. B. OPPELT *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 p 227-234 Oct. 1990
Avail: NTIS HC/MF A20

The investigation determined the survivability and effect on combustion efficiency of several candidate liner materials for ramjet solid fuel screening tests. A liner is necessary both to protect the combustor walls and to reduce heat loss from the combustion chamber. This heat loss can result in incomplete combustion and poor performance. Both a hydrocarbon and a boron fuel were used to compare the liner's effect on the combustion of these fuel types. A finite element heat conduction model constructed prior to testing indicated that the boron nitride (BN) liner would allow nearly the heat loss of stainless steel, and thus, result in poor measured performance compared to a better insulated combustor. The results of the testing show this to be true for the hydrocarbon fuel. Slag deposits on the liner walls from the boron fuel help insulate the liners and reduced their effect on measured performance. A ceramic liner of a boron nitride/aluminum nitride composition (BN/AlN) withstood the thermal environment and insulated well. Measured combustion efficiency was higher for the BN/AlN liner than for DC 93-104, the accepted liner of choice for ramjet testing. This showed that the choice of liner material can affect performance results, and in the case of DC 93-104, indicated care must be taken to use an adequate thickness of insulator.
Author

11

CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

A91-37182
DETECTION OF TRACES OF WATER IN AVIATION KEROSENES BY GAS CHROMATOGRAPHY [OPREDELENIE SLEDOV VODY V AVIATSIONNYKH KEROSINAKH METODOM GAZOVOI KHROMATOGRAFII]
V. L. ZHEREBTSOV and T. V. TIMOFEEVA (NPO Gosudarstvennyi Institut Prikladnoi Khimii, Leningrad, USSR) Khimiia i Tekhnologiia Topliv i Masel (ISSN 0023-1169), no. 3, 1991, p. 33. In Russian. refs
Copyright

A highly sensitive method for detecting trace amounts of water in aviation kerosenes using direct gas chromatography is demonstrated for T-6 and T-1 fuels and naphthyl. The chromatographic analysis was carried out under the following optimal conditions: gas (helium) flow rate, 40 cu cm/min; evaporator temperature, 300 C; column temperature, 100 C; detector temperature, 120 C; detector current, 120 mA; and sample volume, 0.1-0.2 ml. Typical chromatograms of the aviation kerosenes are presented. The sensitivity of the method is 0.0001 percent by mass or better; the results are reproducible to within 10 percent.
V.L.

A91-38129
METHANOL - AN ENVIRONMENTALLY ATTRACTIVE ALTERNATIVE COMMERCIAL AVIATION FUEL
ROBERT O. PRICE (Harmsworth Associates, Laguna Hills, CA) IN: IECEC-90; Proceedings of the 25th Intersociety Energy Conversion Engineering Conference, Reno, NV, Aug. 12-17, 1990. Vol. 4. New York, American Institute of Chemical Engineers, 1990, p. 331-336. refs
Copyright

Southern California's reliance on petrolium-fueled transportation has resulted in significant air pollution problems within the South Coast Air Basin. To deal with this issue, recently enacted state legislation has proposed mandatory introduction of clean alternative fuels into ground transportation fleets operating within this area. The commercial air transportation sector, however, also exerts a significant impact on regional air quality which may result in exceeding emission gains achieved in the ground transportation sector. The author addresses the potential, through the implementation of methanol as a commercial aviation fuel, to improve regional air quality within the Basin. This perceived benefit has formed the basis for a proposal, recently submitted to the California Energy Commission, to flight test and demonstrate methanol as an environmentally preferable fuel in aircraft turbine engines. I.E.

A91-38802
MODELING OF CREEP-FATIGUE INTERACTION EFFECTS ON CRACK GROWTH
KENNETH R. BAIN (General Electric Co., Cincinnati, OH) and REGIS M. PELLOUX (MIT, Cambridge, MA) IN: Elevated temperature crack growth; Proceedings of the Symposium, ASME Winter Annual Meeting, Dallas, TX, Nov. 25-30, 1990. New York, American Society of Mechanical Engineers, 1990, p. 1-6. refs
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The accurate prediction of fatigue crack growth rates at elevated temperature has become a critical problem in the design of advanced gas turbine engines. A typical mission for gas turbine materials has significant cyclic loads combined with both high temperature and extended holds at load. Performing a matrix of tests which allows interpolative modeling of these parameters can be very expensive and the models themselves may have limited effectiveness. A model based on linear superposition of creep crack growth and fatigue crack growth will not only allow accurate prediction of fatigue crack growth rates for a wide variety of cycling conditions, but will reduce the number of tests required to estimate the behavior of a material to only three tests. A mechanistic model for predicting the effects of R-ratio, hold time, frequency, and temperature on fatigue crack growth has been developed which accurately predicts all of these effects. Author

A91-38809
FATIGUE CRACK GROWTH IN MONOLITHIC TITANIUM ALUMINIDES
F. K. HAAKE, D. P. DELUCA, K. P. HOLLAND (Pratt and Whitney Group, West Palm Beach, FL), and G. C. SALIVAR (Florida Atlantic University, Boca Raton) IN: Elevated temperature crack growth; Proceedings of the Symposium, ASME Winter Annual Meeting, Dallas, TX, Nov. 25-30, 1990. New York, American Society of Mechanical Engineers, 1990, p. 79-86.
(Contract F33615-85-C-5029)
Copyright

Tactical aircraft engine designs depend on advanced materials technology to meet performance and durability goals. Monolithic titanium aluminides are currently being developed for potential use in gas turbine engine components where they offer strength and stiffness advantages at temperatures above conventional titanium alloy capabilities. The primary limitations of these alloys have been

low ductility at low temperatures and uncertainty about fatigue and fracture capabilities. This paper will address fatigue crack growth of alpha-2 titanium aluminides. The effects of temperature, stress ratio, and frequency on fatigue crack growth rates will be reviewed. Some observations on crack closure in the near-threshold region will be presented. The crack growth behavior of these alloys will be compared to conventional titanium alloys. Finally, some conclusions will be drawn about the potential use of these materials in future engines. Author

A91-38812
FATIGUE CRACK GROWTH MODELING AT ELEVATED TEMPERATURE USING FRACTURE MECHANICS
T. NICHOLAS (USAF, Wright Research and Development Center, Wright-Patterson AFB, OH) IN: Elevated temperature crack growth; Proceedings of the Symposium, ASME Winter Annual Meeting, Dallas, TX, Nov. 25-30, 1990. New York, American Society of Mechanical Engineers, 1990, p. 107-112. refs
(Contract AF PROJECT 2302P1)
Copyright

Crack growth rates at elevated temperature are represented at the sum of cycle- and time-dependent terms. Parameters are introduced to account for environmental degradation as well as the blunting effect due to creep or stress relaxation under sustained-load hold times. A new model is shown to have sufficient flexibility to represent a wide variety of elevated temperature crack growth rate behavior. Growth rates in a nickel-base superalloy and a titanium aluminide alloy are well represented by the model which uses the linear elastic fracture mechanics parameter, K. Numerical examples are presented which illustrate the various features of the model. Author

A91-38819* General Electric Co., Cincinnati, OH.
APPLICATION OF PATH-INDEPENDENT INTEGRALS TO ELEVATED TEMPERATURE CRACK GROWTH
K. S. KIM and R. H. VAN STONE (GE Aircraft Engines, Cincinnati, OH) IN: Elevated temperature crack growth; Proceedings of the Symposium, ASME Winter Annual Meeting, Dallas, TX, Nov. 25-30, 1990. New York, American Society of Mechanical Engineers, 1990, p. 155-167. refs
(Contract NAS3-23940)
Copyright

The applicability of the J-integral in elasto-plastic fracture mechanics is limited to isothermal, monotonic loading conditions from the theoretical viewpoint, while in many applications, for instance gas turbine engines, crack growth occurs in the presence of cyclic inelastic loading, thermomechanical loading and temperature gradients. A number of path-independent (P-I) integrals have been proposed which do not have the restrictions of the J-integral. A review indicates that four of these integrals, although they are not the classical conservation integrals, are path-independent under these complex loading conditions. This paper describes a combined analytical and experimental effort to evaluate the ability of these four P-I integrals to correlate the crack growth data of Alloy 718 at elevated temperatures. Results for uniform temperature, 538 C, cases indicate that all these integrals are capable of correlating the crack growth data over a wide range of cyclic plasticity. Author

A91-39302
TITANIUM ALUMINIDES FOR AEROSPACE APPLICATIONS
JAMES M. LARSEN, KATHERINE A. WILLIAMS, STEPHEN J. BALSONE, and MONICA A. STUCKE (USAF, Materials Laboratory, Wright-Patterson AFB, OH) IN: High temperature aluminides and intermetallics; Proceedings of the 1st Symposium, Indianapolis, IN, Oct. 1-5, 1989. Warrendale, PA, Minerals, Metals and Materials Society, 1990, p. 521-556. refs
(Contract AF PROJECT 2302P101)
Copyright

The Integrated High Performance Turbine Engine Technology (IHPTET) Initiative and the development of manned hypersonic vehicles represent major new requirements for materials having high weight-specific properties and good environmental resistance at elevated temperatures. In their monolithic form, and as a matrix material for continuous fiber composites, titanium aluminides are important candidates to fill these needs in the intermediate-temperature regime of 600 C to 1000 C. Before these materials can become flight worthy, however, they must demonstrate reliable mechanical behavior over the range of anticipated service conditions. This paper outlines current trends toward utilization of titanium aluminides in aerospace structures, and a summary of a broad range of mechanical properties characteristic of various titanium aluminide materials is presented. Finally, the mechanical properties of monolithic and composite titanium aluminide materials are compared and contrasted with properties of a competing state-of-the-art titanium alloy and a nickel-base superalloy. Author

A91-39389* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HELICOPTER IN-FLIGHT STORES JETTISON
LAURENCE J. BEMENT (NASA, Langley Research Center, Hampton, VA), DIRCK JAHSMAN (Teledyne McCormick Selph, Hollister, CA), and MORRY L. SCHIMMEL (Schimmel Co., Saint Louis, MO) IN: Annual SAFE Symposium, 27th, New Orleans, LA, Dec. 5-8, 1989, Proceedings. Newhall, CA, SAFE Association, 1990, p. 154-159.
Copyright

A helicopter emergency external-stores jettison system accommodating an experimental simplified mounting system is presented. The system's conceptual approach is described, including store interface, attachment, functional mechanisms, and system initiation. It is novel both in the stores' mounting interface logic and in the modifications to existing technology for the components. Two nonfragmenting 'ridge cut' explosive bolts were mounted in each 600-pound store to interface with a simple plate on the aircraft. Starting designs with proven technology and functional margins were demonstrated by analysis and test through the design and development. Design details of the system's components, from the explosive bolt to the initiation handle, are described. P.D.

A91-39690#
KINETIC STUDY OF A HOMOGENEOUS PROPELLANT PRIMARY FLAME, WITH AND WITHOUT ADDITIVE
F. FADDOUL (Scientific Research Center, Alep, Syria), J. M. MOST, and P. JOULAIN (CNRS, Laboratoire de Chimie Physique de la Combustion, Mignaloux-Beauvoir, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 6, 1990, p. 1-13. refs
Copyright

A pseudo-detailed mechanism is presented as an initial kinetic scheme, which is then reduced to three reactions, a homogeneous one summarizing the different reactions between the gaseous species, and two heterogeneous reactions describing the consumption of solid carbon particles in the flow. The mass fraction of NO2 is considered as the degree of progress of the reaction and the heat production rate is expressed as a function of the mass fraction of NO2 and the power 0.4 of the pressure. Comparison of the results obtained when taking or not taking mass and thermal diffusions into account demonstrates the validity of the simplified approach employed to determine the solution of a kinetic problem applied to the study of a premixed flame stabilized on a double base solid propellant grain. R.E.P.

A91-40178
NON METALLIC MATERIALS FOR GAS TURBINE ENGINES - ARE THEY REAL?
CHESTER T. SIMS (Rensselaer Polytechnic Institute, Troy, NY) Advanced Materials and Processes (ISSN 0882-7958), vol. 139, June 1991, p. 32-39. refs
Copyright

Since the thrust efficiency of gas turbines is maximized with increasing turbine inlet temperature, efforts are underway to achieve the 2200 C stoichiometric combustion temperature of commercial jet fuels, which is about 500 C above current temperatures; such

an operating temperature, however, entails improvements in turbine structural materials' performance levels which have for several years been addressed by research with low-density ceramics and intermetallics. Typical monolithic nonoxide ceramics investigated have been Si3N4, SiC, and Si-Al-O-N, while oxides encompass Al2O3 and ZrO2, and intermetallics include the Ni and Nb aluminides. It is judged that all such efforts have fallen far short of expectations, and that higher combustion temperatures will more easily and economically be accommodated by more refined use of superalloy blading and ceramic thermal-barrier coatings. O.C.

A91-40425
NKK PREMIUM QUALITY TITANIUM MASTER ALLOY
TAKANORI ONO, TOSHIO NAYUKI, TOSHIAKI ISHIDA, KEIICHI NAKAGAWA, IEHISA TAKEZAWA (NKK Corp., Advanced Materials Div., Toyama, Japan) et al. NKK Technical Review (ISSN 0915-0544), April 1991, p. 66-74.
Copyright

The aluminothermic reduction process has been combined with vacuum-induction melting to produce master alloys of the exceptional quality required for Ti-alloy-based aerospace propulsion components. The master alloy compositions are Al-V, Al-Mo, Al-V-Sn, Al-Mo-V, V-Cr-Al, V-Fe-Al, and Al-Nb-Ta; representative Ti alloys thus produced encompass Ti-6Al-4V, Ti-8Al-1Mo-1V, Ti-6Al-6V-2Sn, and Ti-10V-2Fe-3Al. A development history is presented for the master alloy production facilities used. The quality assurance system for the master alloys involved the control of raw material suppliers, maintenance of traceability, and extensive use of standard reference samples. O.C.

N91-23248# Aerospatiale, Toulouse (France).
OBSERVATORY OF NEW MATERIALS. EVOLUTION PERSPECTIVES FOR THE MATERIALS USED IN CIVIL TRANSPORTATION AIRCRAFT [OBSERVATOIRE DES MATERIAUX NOUVEAUX. PERSPECTIVES D'EVOLUTION DES MATERIAUX UTILISES DANS LES AVIONS DE TRANSPORT CIVIL]
A. FERRAN 31 Jan. 1991 48 p In FRENCH
(REPT-911-111-107; ETN-91-99271) Avail: NTIS HC/MF A03

It is shown that, in aeronautics, each material innovation is the cause of reactions in other competitive materials. The evolution of metallic and organic materials is considered. Aluminum alloys improvements were made with regard to fatigue strength, corrosion behavior, and damage tolerances. Newly developed aluminum lithium alloys showed a 9 pct. mass gain potential. New aluminum alloys, new titanium alloys, and new steels are presented. Titanium alloys are discussed. Titanium superplastic forming and diffusion bonding is illustrated. Landing gear steels and structural steel properties are given. Metallic Matrix Composite (MMC) evolution is presented. Aluminum matrix material characteristics are given. New materials for civil aircrafts are presented. A marked evolution towards composite material utilization is focused. ESA

N91-23251# Aerospatiale Aquitaine, Saint-Medard en Jalles (France). Strategic and Space Div.
OXIDATION RESISTANT CARBON/CARBON MATERIALS
O. FRANC and JEAN-LUC MACRET 1991 5 p
(REPT-911-430-105; ETN-91-99277) Avail: NTIS HC/MF A01

A research and development program in Ceramic Matrix Composites (CMC) and oxidation resistant Carbon/Carbon (C/C Inox) is discussed. The proposal for C/C Inox to be used for the nose cap and wing leading edge of the Hermes Spaceplane is discussed. The fabrication of C/C material (weaving and densification) and C/C PAO (Protection Against Oxidation) including silicidation and PAO for leading edges and nose caps are described. C/C is concluded to have an excellent stability of properties in temperatures up to 3000 C but due to oxidation sensitivity a PAO is needed for application on space planes. ESA

N91-23262# Aerospatiale Aquitaine, Saint-Medard en Jalles (France). Strategic and Space Div.
HOW TO KNOW CMC
F. ALBUGUES and P. PERES 1991 13 p Previously announced as N91-11865
(REPT-911-430-130; ETN-91-99302) Avail: NTIS HC/MF A03

Thermostructural development of CMC (Ceramic Matrix Composites) is summarized. Nondestructive test methods, mechanical characterization and mathematical modeling are discussed. Production of structural composite materials for use in wing leading edges and nose caps of reusable space vehicles is addressed. Mechanical test validity of test sample, fracture behavior modeling and mechanical tests related to microstructure are described. The synergy of the different approaches presented is concluded to give much information and elements of behavior understanding for the 'young materials' that are CMC. ESA

N91-23270 Stanford Univ., CA.
THE EFFECTS OF CONTROLLING VORTEX FORMATION ON THE PERFORMANCE OF A DUMP COMBUSTOR Ph.D. Thesis
KEITH ROBERT MCMANUS 1990 223 p
Avail: Univ. Microfilms Order No. DA9102314

The use of flow control methods to improve the performance of air breathing combustors, specifically with respect to controlling both volumetric energy release and combustion instability, is investigated. The flow control techniques were chosen for their ability to control vortex formation near the inlet of the combustor. Periodic spanwise forcing of the inlet boundary layer was used to control the spanwise vortex shedding process in the combustor. Delta wing vortex generators and vortex generator jets were used to introduce streamwise vorticity into the flow. These control strategies were applied separately and together to a laboratory-scale dump combustor, and the effects on combustor performance were determined. The effect of spanwise forcing on both nonreacting and reacting flowfields was to modulate the formation of spanwise coherent vortex structures just downstream of the flow separation. In the nonreacting flowfield, the shear layer spreading rate was increased when forcing was applied. In the reacting flow, forcing caused a modulation of the flame structure. Dissert. Abstr.

N91-24358*# Boeing Commercial Airplane Co., Seattle, WA.
ENVIRONMENTAL EXPOSURE EFFECTS ON COMPOSITE MATERIALS FOR COMMERCIAL AIRCRAFT Final Report, 22 Nov. 1977 - 31 Dec. 1990
DANIEL J. HOFFMAN and WILLIAM J. BIELAWSKI Jan. 1991 129 p
(Contract NAS1-15148)
(NASA-CR-187478; NAS 1.26:187478) Avail: NTIS HC/MF A07 CSCL 11/4

A study was conducted to determine the effects of long term flight and ground exposure on three commercially available graphite-epoxy material systems: T300/5208, T300/5209, and T300/934. Sets of specimens were exposed on commercial aircraft and ground racks for 1, 2, 3, 5, and 10 years. Inflight specimen sites included both the interior and exterior of aircraft based in Hawaii, Texas, and New Zealand. Ground racks were located at NASA-Dryden and the above mentioned states. Similar specimens were exposed to controlled lab conditions for up to 2 years. After each exposure, specimens were tested for residual strength and a dryout procedure was used to measure moisture content. Both room and high temperature residual strengths were measured and expressed as a pct. of the unexposed strength. Lab exposures included the effects of time alone, moisture, time on moist specimens, weatherometer, and simulated ground-air-ground cycling. Residual strengths of the long term specimens were compared with residual strengths of the lab specimens. Strength retention depended on the exposure condition and the material system. Results showed that composite materials can be successfully used on commercial aircraft if environmental effects are considered. Author

N91-24451*# Ford Motor Co., Dearborn, MI.
IMPROVED SILICON CARBIDE FOR ADVANCED HEAT ENGINES Final Technical Report
THOMAS J. WHALEN May 1989 60 p

(Contract NAS3-24384)
(NASA-CR-182289; NAS 1.26:182289) Avail: NTIS HC/MF A04 CSCL 11/3

The development of high strength, high reliability silicon carbide parts with complex shapes suitable for use in advanced heat engines is studied. Injection molding was the forming method selected for the program because it is capable of forming complex parts adaptable for mass production on an economically sound basis. The goals were to reach a Weibull characteristic strength of 550 MPa (80 ksi) and a Weibull modulus of 16 for bars tested in four-point loading. Statistically designed experiments were performed throughout the program and a fluid mixing process employing an attritor mixer was developed. Compositional improvements in the amounts and sources of boron and carbon used and a pressureless sintering cycle were developed which provided samples of about 99 percent of theoretical density. Strengths were found to improve significantly by annealing in air. Strengths in excess of 550 MPa (80 ksi) with Weibull modulus of about 9 were obtained. Further improvements in Weibull modulus to about 16 were realized by proof testing. This is an increase of 86 percent in strength and 100 percent in Weibull modulus over the baseline data generated at the beginning of the program. Molding yields were improved and flaw distributions were observed to follow a Poisson process. Magic angle spinning nuclear magnetic resonance spectra were found to be useful in characterizing the SiC powder and the sintered samples. Turbocharger rotors were molded and examined as an indication of the moldability of the mixes which were developed in this program. Author

N91-24453# Sandia National Labs., Albuquerque, NM.
ADVANCED THERMALLY STABLE JET FUELS DEVELOPMENT PROGRAM ANNUAL REPORT. VOLUME 3: FUEL LUBRICITY Interim Technical Report, Jun. 1989 - Oct. 1990
JOHN P. CUELLAR, JR. 15 Jan. 1991 28 p
(Contract DE-AC04-76DP-00789; FY1455-89-N-0635)
(AD-A232793; WRDC-TR-90-2079-VOL-3) Avail: NTIS HC/MF A03 CSCL 21/4

A program to evaluate the effects of additives on JP-8 fuel lubricity at high temperatures is described. Operating temperatures up to 163 C were examined, with a subsequent program goal of 315 C. Baseline data were obtained using the Ball-on-Cylinder Lubricity Evaluator (BOCLE). High-temperature data were obtained with an apparatus known as the Cameron-Plint High Frequency Reciprocating Machine. The most significant effect of variables observed was a consequence of a change in wear specimen material from 52100 steel to M-50 steel--the latter considered to be representative of advanced fuel system designs. Use of M-50 wear coupons resulted in considerably reduced wear levels with only slight separation between neat or additized fuels. M-50 specimen roughness was a major influence in wear level. At finalized test conditions, a dibasic acid ester, di(2-ethylhexyl) adipate, was found to give the lowest wear values when used as an additive in clay-treated JP-8, although distinctions between the various additized fuels were not large. GRA

12

ENGINEERING

Includes engineering (general); communications; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

A91-36450* Syracuse Univ., NY.
AN ISENTROPIC COMPRESSION-HEATED LUDWEIG TUBE TRANSIENT WIND TUNNEL
PATRICK J. MAGARI and JOHN E. LAGRAFF (Syracuse University, NY) Experimental Thermal and Fluid Science (ISSN 0894-1777), vol. 4, May 1991, p. 317-332. refs
(Contract NAG3-621)
Copyright

Theoretical development and experimental results show that the Ludweig tube with isentropic heating (LICH) transient wind tunnel described is a viable means of producing flow conditions that are suitable for a variety of experimental investigations. A complete analysis of the wave dynamics of the pump tube compression process is presented. The LICH tube operating conditions are very steady and run times are greater than those of other types of transient facilities such as shock tubes and gas tunnels. This facility is well suited for producing flow conditions that are dynamically similar to those found in a gas turbine, i.e., transonic Mach number, gas-to-wall temperature ratios of about 1.5, and Reynolds numbers greater than 10 to the 6th. R.E.P.

A91-36698#
NEW DEVELOPMENTS IN THE DYNAMIC AEROELASTIC STABILITY STUDY OF ROTOR BLADES
V. GIURGIUTIU, L. GAITA (Institutul National pentru Creatie Stiintifica si Tehnica, Bucharest, Rumania), and F. ONCESCU (Polytechnic Institute, Bucharest, Rumania) Revue Roumaine des Sciences Techniques, Serie de Mecanique Appliquee (ISSN 0035-4074), vol. 35, Mar.-Apr. 1990, p. 137-146. refs

Improvements to a method originally developed for the analysis of the dynamic aeroelastic stability of rotor blades are discussed. These include the capability to handle hinge-blade boundary conditions, rotating torsion models, cone angle correction, and the use of lag damper. A two-point boundary problem is used as an example. The problem is solved using the shooting method and the Galerkin expansion with rotating torsion modes. V.L.

A91-36896
ROBOTIC SENSORS FOR AIRCRAFT PAINT STRIPPING
RICHARD J. WENIGER (Southwest Research Institute, San Antonio, TX) Society of Manufacturing Engineers, Conference on Aerospace Automation and Fastening, Arlington, TX, Oct. 9-11, 1990. 12 p.
(Contract F33615-86-C-5044)
(SME PAPER MS90-282) Copyright

Aircraft of all types need to have paint routinely removed from their outer surfaces. Any method needs to be controlled to remove all the paint and not damage the surface of the aircraft. Human operators get bored with the monotonous task of stripping paint from an aircraft and thus do not control the process very well. This type of tedious operation tends itself to robotics. A robot that strips paint from aircraft needs to have feedback as to the state of the stripping process, its location in respect to the aircraft, and the availability of stripping material. This paper describes the sensors used on the paint stripping robot being developed for the United States Air Force's Manufacturing Technology Program. Particular attention is given to the paint sensor which is the feedback element for determining the state of the stripping process. Author

A91-36943
AUTOMATED CAD DESIGN FOR SCULPTURED AIRFOIL SURFACES
S. D. MURPHY and S. R. YEAGLEY (Textron, Inc., Danville, PA) Society of Manufacturing Engineers, Conference on Autofact '90, Detroit, MI, Nov. 12-15, 1990. 12 p.
(SME PAPER MS90-744) Copyright

The design of tightly tolerated sculptured surfaces such as those for airfoils requires a significant design effort in order to machine the tools to create these surfaces. Because of the quantity of numerical data required to describe the airfoil surfaces, a CAD approach is required. Although this approach will result in productivity gains, much larger gains can be achieved by automating the design process. This paper discusses an application which resulted in an eightfold improvement in productivity by automating the design process on the CAD system. Author

A91-37052#
THE PLANAR ELEMENTS METHOD FOR COMPUTING THE SCATTERING FIELD OF FLIGHT VEHICLE
GUOZHONG MA and JIADONG XU (Northwestern Polytechnical University, Xian, People's Republic of China) Northwestern Polytechnical University, Journal (ISSN 1000-2758), vol. 9, April 1991, p. 140-144. In Chinese, with abstract in English. refs

In order to both improve the accuracy and reduce the computation time of the EM scattering field of an electrically conductive body, a novel 'planar elements' method is proposed which allows the curved surface to be represented by a set of planar elements; the sum of these planar elements' field is taken to be the approximation of scattering characteristics for the entire body. This fast and accurate method can systematically employ the planar-elements information of aerodynamics calculations to compute a low radar cross-section vehicle's optimal configuration. O.C.

A91-37106
MEASUREMENT OF CLUTTER SUPPRESSION USING A QUADRAHEDRAL
JOSEPH A. BRUDER (Georgia Institute of Technology, Atlanta) IN: Noise and clutter rejection in radars and imaging sensors; Proceedings of the 2nd International Symposium, Kyoto, Japan, Nov. 14-16, 1989. Amsterdam, Elsevier Science Publishers, 1990, p. 287-292.
Copyright

Sophisticated radar processing techniques for clutter suppression primarily rely upon the Doppler produced from a moving target to separate it from clutter. Actual measurements of a Doppler-producing target of known radar cross section (RCS) are necessary to fully evaluate the clutter rejection of a radar. This paper discusses the development of the 'Quadrahedral' reflector that provides an ideal 'moving target' Doppler-shifted return and includes the results of the moving target indication (MTI) improvement factor measurements performed in June of 1988 on the U.S. Customs SOWRBALL Aerostat Radar. Author

A91-37141
TRACK INITIATION USING MHT IN DENSE ENVIRONMENTS
HISAO IWAMA, YOSHIO KOSUGE, TOSHIKI AIBA, and HIROMICHI KAWAZOE (Mitsubishi Electric Corp., Kamakura Works, Japan) IN: Noise and clutter rejection in radars and imaging sensors; Proceedings of the 2nd International Symposium, Kyoto, Japan, Nov. 14-16, 1989. Amsterdam, Elsevier Science Publishers, 1990, p. 608-613.
Copyright

The use of a new method, multiple hypothesis tracking (MHT), to improve the performance of track initiation in dense environments is discussed. The MHT uses the detection and false alarm statistics of the sensor, the expected density of a new target, and the accuracy of the target estimates to obtain posterior probabilities for each observation. A number of candidate hypotheses are generated, and the posterior probabilities of the hypotheses are calculated recursively using the Bayes rule. Results of a computer simulation are presented to demonstrate the efficiency of the method. V.L.

A91-37269
RESIDUAL STRESS CONTROL IN DEVELOPING PROCESSES FOR THE MANUFACTURE OF COMPRESSOR BLADES FOR GAS TURBINE ENGINES [KONTROL' OSTATOCHNYKH NAPRIAZHENII PRI OTRABOTKE TEKHNOLOGICHESKIKH PROTSESSOV IZGOTOVLENIIA LOPATOK KOMPRESSOROV GTD]
V. A. BOGUSLAEV (Proizvodstvennoe Ob'edinenie Motorostroitel', Zaporozhe, Ukrainian SSR) Problemy Prochnosti (ISSN 0556-171X), March 1991, p. 30-33. In Russian. refs
Copyright

Methods for generating and controlling residual surface stresses in compressor blades of titanium alloys are examined with reference to production experience in the manufacture of compressor blades of VT3-1 and VT8 alloys. It is shown that residual stresses have a noticeable effect on the fatigue strength of the blade foil. The fatigue strength of the blades can be substantially improved by using manufacturing processes that create residual compressive stresses in the blade surface layer. V.L.

A91-37375
FABRICATION OF ENGINEERING CERAMICS BY INJECTION MOLDING
MOHAN J. EDIRISINGHE (Brunel University, Uxbridge, England) American Ceramic Society Bulletin (ISSN 0002-7812), vol. 70, May 1991, p. 824-828. SERC-supported research. refs
Copyright

The injection molding of ceramic-polymer suspensions allows the automated near-net-shape fabrication of complex shapes, such as advanced gas turbine rotors. Here, the principal stages and general features of a ceramic injection molding process are discussed, as are the most important process parameters. Some typical injection molding defects and their underlying causes are examined. V.L.

A91-37410#
AIRBLAST ATOMIZATION AT CONDITIONS OF LOW AIR VELOCITY
A. H. LEFEBVRE (Purdue University, West Lafayette, IN), T. R. KOBLISH (Textron Corp., Walled Lake, MI), and J. E. BECK Journal of Propulsion and Power (ISSN 0748-4658), vol. 7, Mar.-Apr. 1991, p. 207-212. Previously cited in issue 09, p. 1346, Accession no. A89-25191. refs
Copyright

A91-37414#
SUBSONIC AND SUPERSONIC COMBUSTION USING NONCIRCULAR INJECTORS
E. GUTMARK, K. C. SCHADOW, and K. J. WILSON (U.S. Navy, Naval Weapons Center, China Lake, CA) Journal of Propulsion and Power (ISSN 0748-4658), vol. 7, Mar.-Apr. 1991, p. 240-249. refs

Nonreacting and combustion tests were performed for subsonic, sonic, and supersonic conditions using noncircular injectors in a gas generator combustor. The noncircular injectors, including square, equilateral-, and isosceles-triangular nozzles, were compared to a circular injector. The flowfields of the jets were mapped with hot-wire anemometry and visualized using spark schlieren photography. The combustion characteristics were visualized by high-speed photography and thermal imaging, and the temperature distribution was measured by a rake of thermocouples. The present tests conducted at high Reynolds and Mach numbers confirmed earlier results obtained for the low range of these numbers, i.e., the combination of large-scale mixing at the flat sides with the fine-scale mixing at the vertices is benefical for combustion. Large-scale structures provide bulk mixing between the fuel and air, whereas fine-scale mixing contributes to the reaction rate and to better flameholding characteristics. Author

A91-37774#
ANALYTICAL STUDIES ON STATIC AEROELASTIC BEHAVIOR OF FORWARD-SWEPT COMPOSITE WING STRUCTURES
LIVIU LIBRESCU and SUROT THANGJITHAM (Virginia Polytechnic Institute and State University, Blacksburg) (Structures, Structural Dynamics and Materials Conference, 29th, Williamsburg, VA, Apr. 18-20, 1988, Technical Papers. Part 1, p. 28-36) Journal of Aircraft (ISSN 0021-8669), vol. 28, Feb. 1991, p. 151-157. Previously cited in issue 12, p. 1902, Accession no. A88-32180. refs
Copyright

A91-37834*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
CELL CENTERED AND CELL VERTEX MULTIGRID SCHEMES FOR THE NAVIER-STOKES EQUATIONS
R. C. SWANSON (NASA, Langley Research Center, Hampton, VA) and R. RADESPIEL (DLR, Institut fuer Entwurfsaerodynamik, Brunswick, Federal Republic of Germany) AIAA Journal (ISSN

0001-1452), vol. 29, May 1991, p. 697-703. Previously cited in issue 09, p. 1350, Accession no. A89-25440. refs
Copyright

A91-37845*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
STUDY OF THERMAL-EXPANSION-MOLDED, GRAPHITE-EPOXY HAT-STIFFENED SANDWICH PANELS
DAWN C. JEGLEY (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 29, May 1991, p. 778, 779. Abridged. Previously cited in issue 12, p. 1861, Accession no. A89-30878.
Copyright

A91-37846#
ASYMPTOTIC THEORY OF BENDING-TORSION FLUTTER OF HIGH ASPECT RATIO WING IN THE TORSION CONTROLLED DOMAIN
GABRIEL KARPOUZIAN (U.S. Naval Academy, Annapolis, MD) AIAA Journal (ISSN 0001-1452), vol. 29, May 1991, p. 780, 781. Research supported by U.S. Naval Academy.
Copyright

An asymptotic theory of bending-torsion flutter of a high aspect ratio wing with a unit-order bending-torsion stiffness ratio is developed. Two distinct (high and low) frequency domains are identified. For illustration, detailed analysis is carried out only in the high-frequency domain. The methodology is general and may be applicable to various wing configurations. To substantiate its adequacy, the classical case of a uniform unswept cantilever wing in an incompressible airflow is treated as a case study. The asymptotic results for flutter eigenvalues and mode shapes compare favorably with those obtained by a more exact treatment. Author

A91-37847#
SUPERSONIC FLUTTER ANALYSIS OF CLAMPED SYMMETRIC COMPOSITE PANELS USING SHEAR DEFORMABLE FINITE ELEMENTS
IN LEE (Korea Advanced Institute of Science and Technology, Seoul, Republic of Korea) and MAENG-HYO CHO AIAA Journal (ISSN 0001-1452), vol. 29, May 1991, p. 782, 783. Abridged.
Copyright

The flutter analysis of composite panels in supersonic flow has been performed by the finite element method based on the first-order shear deformable theory. The computational results of the vibration and flutter analysis agree well with the results given in the available references. Flutter boundaries have been obtained for both cross-ply and angle-ply composite plates. Also, the flutter analysis has been performed for both rectangular and trapezoidal plates with clamped edges. The plate aspect ratio, flow direction, and fiber orientation affect greatly the flutter boundaries. Author

A91-37851#
DESIGN OF AIRCRAFT WINGS SUBJECTED TO GUST LOADS - A SAFETY INDEX BASED APPROACH
J.-S. YANG (Aerostructures, Inc., Arlington, VA) and E. NIKOLAIDIS (Virginia Polytechnic Institute and State University, Blacksburg) AIAA Journal (ISSN 0001-1452), vol. 29, May 1991, p. 804-812. refs
Copyright

A method for system reliability based design of aircraft wings is presented. The advanced first-order, second-moment (AFOSM) method is employed in evaluating reliability. A wing of a commuter aircraft designed by the FAA regulations is compared to one designed by system reliability optimization. Two cases are considered for which the correlation between failure modes is neglected or is accounted for, respectively. The results demonstrate the potential of system reliability optimization and the benefits from employing the AFOSM method. Furthermore, they allow us to identify the limitations of simple methods utilizing the first-order Ditlevsen bounds for evaluating system reliability and to assess the advantages of more sophisticated system reliability based methods that account for the correlation between the failure modes. It is shown that, if a penalty function method is employed for optimization, the upper Ditlevsen bound can be used to approximate the system reliability without encountering any problems due to the discontinuity of the derivatives of the constraints. Author

A91-37880
RADIATION TRANSMISSION IN ADVERSE WEATHER
STUART W. GREENWOOD (University Research Foundation, Greenbelt, MD) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985), vol. 6, April 1991, p. 3-6. refs
Copyright

A simplified practical approach to determining the effects of weather on the transmission of radiation at visible, infrared (IR), and millimeter (MM) wavelengths, with particular reference to the aircraft landing problem, is outlined. Passive landing systems are studied. Landing categories related to visibility are defined. An extinction coeffcient used to relate the effect of the atmosphere on the radiation detected by the human eye (or an imaging sensor onboard the aircraft) to the landing category and the calculation of this coefficient are discussed. The approach makes use of data from openly available literature. Results have been found useful in indicating the effects of adverse weather on imaging sensor performance for an enhanced vision aircraft-mounted landing system. As an example of the technique, the method of determining the extinction coefficients in fog for infrared radiation is outlined. I.E.

A91-38689
VORTEX SHEDDING AND LOCK-ON IN BLUFF BODY WAKES
O. M. GRIFFIN (U.S. Navy, Naval Research Laboratory, Washington, DC) and M. S. HALL (Science Applications International Corp., McLean, VA) IN: International Symposium on Nonsteady Fluid Dynamics, Toronto, Canada, June 4-7, 1990, Proceedings. New York, American Society of Mechanical Engineers, 1990, p. 209-218. U.S. Navy-supported research. refs
Copyright

The results of recent experiments demonstrate that the phenomenon of vortex shedding resonance or lock-on is observed also when a bluff body is placed in a superimposed mean plus periodic incident flow. This form of vortex shedding and lock-on exhibits a particularly strong resonance between the flow perturbations and the vortices, and provides one promising means for modification and control of the basic formation and stability mechanisms in the near-wake of a bluff body. Examples are also given of recent direct numerical simulations of the vortex lock-on in the oscillatory flow, and also flow modification using a passive device such as a splitter plate. Both agree well with the results of experiments. The lock-on phenomenon is discussed in the overall context of active and passive wake control on the basis of these and other recent results. Author

A91-38693
THE EFFECT OF STREAMWISE VORTICES ON A TURBULENT BOUNDARY LAYER EXPOSED TO AN UNSTEADY ADVERSE PRESSURE GRADIENT
W. W. HUMPHREYS (USAF, Colorado Spring, CO) and W. C. REYNOLDS (Stanford University, CA) IN: International Symposium on Nonsteady Fluid Dynamics, Toronto, Canada, June 4-7, 1990, Proceedings. New York, American Society of Mechanical Engineers, 1990, p. 285-290. refs
(Contract F49620-86-K-0020)
Copyright

This experiment studied the effect of streamwise vortices on a turbulent boundary-layer exposed to an unsteady adverse pressure gradient in a water tunnel at a momentum thickness Reynolds number of 1840. The streamwise vortices were created by three pairs of half-delta wing vortex generators, while impulsively initiated opposite-wall suction created a strong adverse pressure gradient. The time response of the freestream velocity is characterized by two time scales, an initial fast response throughout the boundary layer which is unaffected by the presence of vortex generators,

followed by a slow or convective response, the magnitude of which is substantially modified by the presence of the vortex generators. Author

A91-38697* Cincinnati Univ., OH.
ANALYSIS AND CONTROL OF LOW-SPEED FORCED UNSTEADY FLOW
U. GHIA and K. N. GHIA (Cincinnati, University, OH) IN: International Symposium on Nonsteady Fluid Dynamics, Toronto, Canada, June 4-7, 1990, Proceedings. New York, American Society of Mechanical Engineers, 1990, p. 321-328. McDonnell Douglas Corp.-supported research. refs
(Contract AF-AFOSR-87-0074; NAG1-753)
Copyright
A capability for numerically simulating 2-D flows in temporally deforming geometries is described, with emphasis on flow with forced unsteadiness, particularly on the simulation and analysis of these flows. The simulation of forced unsteady flows makes the examination of fundamental unsteady flow mechanisms, such as dynamic stall and unsteady separation, possible. A turbulence model is being incorporated into the analysis so as to obtain solutions for the higher Reynolds numbers used in the experiments. The analysis is also of utility in studying fluid-structure interactions, free surfaces, metal-forming, and bio-fluid mechanics involving flow through passages with flexible walls. P.D.

A91-38698* Cairo Univ. (Egypt).
HEAT TRANSFER IN OSCILLATING FLOWS
F. EL-MEHLAWY (Cairo University, Egypt) and R. R. MANKBADI (NASA, Lewis Research Center, Cleveland, OH; Cairo University, Egypt) IN: International Symposium on Nonsteady Fluid Dynamics, Toronto, Canada, June 4-7, 1990, Proceedings. New York, American Society of Mechanical Engineers, 1990, p. 329-337. refs
Copyright
The heat transfer in a sudden-expansion flow subjected to upstream periodic disturbances is investigated. In order to study the unsteady turbulent flow for the present symmetrical sudden-expansion flow, the phase-averaging technique of Hussain and Reynolds (1970) is used to derive the governing equations. The imposed periodic disturbances are found to increase the turbulent kinetic energy and the heat transfer rates at the wall. The phenomenon is discovered to be sensitive to the frequency of the imposed disturbances. At the optimum frequency and at a 3 percent disturbance level, the time-averaged heat transfer rate near the reattachment point can be increased by as much as 14 percent. P.D.

A91-38706
APPLICATION OF VORTEX DYNAMICS TO SIMULATIONS OF TWO-DIMENSIONAL WAKES
D. T. MOOK and B. DONG (Virginia Polytechnic Institute and State University, Blacksburg) IN: International Symposium on Nonsteady Fluid Dynamics, Toronto, Canada, June 4-7, 1990, Proceedings. New York, American Society of Mechanical Engineers, 1990, p. 435-448. refs
(Contract AF-AFOSR-86-0090)
Copyright
The wake generated by a pitching airfoil is considered and a method for simulating flows past solid bodies and their wakes is described. Vorticity panels are used to represent the body, and vortex blobs are used to represent the wake. The rate at which vorticity is shed from the trailing edge is determined by simultaneously requiring the pressures along the upper and lower surface streamlines to approach the same value at the trailing edge and the circulation around the airfoil and its wake to remain constant. The numerical simulation reveals that the wake, which is originally smooth, eventually coils, or wraps, around itself, primarily under the influence of the velocity it induces on itself, and forms regions of relatively concentrated vorticity, called vortical structures. The computed spacing of the structures and the circulations around them are in good agreement with the experimental results. A simulation of the interaction between vorticity in the oncoming stream and a stationary airfoil is considered as well. P.D.

A91-38775
ACTUAL STRESSES IN NOTCHES - HOW APPLICABLE ARE THE COMMON STRESS CONCENTRATION FACTORS?
J. T. PINDERA (Waterloo, University, Canada) and X. LIU (Waterloo, University, Canada; Tsinghua University, Beijing, People's Republic of China) IN: Composite material technology 1990; Proceedings of the Symposium, 13th ASME Annual Energy-Sources Technology Conference and Exhibition, New Orleans, LA, Jan. 14-18, 1990. New York, American Society of Mechanical Engineers, 1990, p. 253-260. refs
(Contract NSERC-A-2939)
Copyright
The empirical evidence presented in this paper has been produced using the resistance strain gages and isodyne techniques. This evidence shows that in regions of notches and cracks in plates, all components of a three-dimensional stress state exist and depend also on the thickness coordinate. The actual stresses and their major functions are 20-30 percent higher than generally assumed. A new concept of the three-dimensional stress concentration factor for plates is suggested. Author

A91-38776* Texas A&M Univ., College Station.
FLEXURAL WAVES INDUCED BY ELECTRO-IMPULSE DEICING FORCES
P. H. GIEN (Texas A & M University, College Station) IN: Composite material technology 1990; Proceedings of the Symposium, 13th ASME Annual Energy-Sources Technology Conference and Exhibition, New Orleans, LA, Jan. 14-18, 1990. New York, American Society of Mechanical Engineers, 1990, p. 267-271. refs
(Contract NAG3-284)
Copyright
The generation, reflection and propagation of flexural waves created by electroimpulsive deicing forces are demonstrated both experimentally and analytically in a thin circular plate and a thin semicylindrical shell. Analytical prediction of these waves with finite element models shows good correlation with acceleration and displacement measurements at discrete points on the structures studied. However, sensitivity to spurious flexural waves resulting from the spatial discretization of the structures is shown to be significant. Consideration is also given to composite structures as an extension of these studies. R.E.P.

A91-38869
FLUID MACHINERY FORUM - 1990; ASME SPRING MEETING, UNIVERSITY OF TORONTO, CANADA, JUNE 4-7, 1990, PROCEEDINGS
UPENDRA S. ROHATGI, ED. (Brookhaven National Laboratory, Upton, NY) Forum sponsored by ASME. New York, American Society of Mechanical Engineers, 1990, 57 p. For individual items see A91-38870 to A91-38875.
Copyright
The present conference discusses aspects of radial loading in centrifugal pumps, the animation of LDV measurements in a centrifugal pump, unsteady flow phenomena in a reversible Francis pump turbine, secondary flow inside a centrifugal pump impeller and its consequent performance, and measurements of the rotordynamic shroud forces for centrifugal pumps. Also discussed are a finite element analysis of the flow in a Francis turbine's labyrinth seal, the shape of a theoretical head-capacity curve for an impeller with a finite number of blades, the automated design of centrifugal impellers, and three-dimensional models of cavitation in rocket engine inducers. O.C.

A91-38874
TOWARD AUTOMATING THE DESIGN OF CENTRIFUGAL IMPELLERS
S. N. J. AL-ZUBAIDY (United Arab Emirates University, Al Ain) IN: Fluid Machinery Forum - 1990; ASME Spring Meeting, Toronto,

Canada, June 4-7, 1990, Proceedings. New York, American Society of Mechanical Engineers, 1990, p. 41-47. refs
Copyright

The paper describes a general method for the design of centrifugal compressor impellers. The proposed design procedure reduces the designer's interruption to the design process. This was achieved by coupling a quasi-three-dimensional flow analysis program with an optimization algorithm for solving nonlinear constraint programming problems, so that to ensure an acceptable diffusion schedule along the flow path. The design optimization was accomplished by a comparative sequence with a targeted distribution which was specified by the designer from the start. The resulting schedule matched relatively well the prescribed profile. The final calculated geometry showed the designed impeller to be well proportioned and not to be difficult to manufacture. Author

A91-39144
EVALUATION OF THE PHASE DISTORTIONS OF THE INPUT SIGNAL OF A SYNTHETIC-APERTURE RADAR [OTSENKA FAZOVYKH ISKAZHENII VKHODNOGO SIGNALA RLS S SINTEZIROVANNOI APERTUROI]
V. I. PRIKLONSKAIA Radiotekhnika (ISSN 0033-8486), March 1991, p. 6-8. In Russian. refs
Copyright

The paper presents an algorithm for modeling the phase distortions of the input signal of an SAR due to trajectory instabilities of the flight vehicle. Using onboard measurement data, the present approach can evaluate changes in the radar image associated with such instabilites. L.M.

A91-39230
SENSITIVITY ANALYSIS, OPTIMIZATION, AND DATA SUPPORT IN FINITE ELEMENT SYSTEMS [ANALIZ CHUVSTVITEL'NOSTI, OPTIMIZATSIIA I IKH INFORMATSIONNOE OBESPECHENIE V MKE-SISTEMAKH]
V. A. ZARUBIN Raschety na Prochnost' (ISSN 0234-1905), no. 32, 1990, p. 151-168. In Russian. refs
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Methods of sensitivity analysis and structural optimization are examined with particular reference to a finite element system for the design of aircraft structures, RIPAK. The discussion focuses on the use of data bases and expert systems for increasing the efficiency of software implementations of the above methods. Particular attention is given to the use of optimality criteria and mathematical programming methods. V.L.

A91-39585
A GENERAL METHOD FOR ROTORDYNAMIC ANALYSIS
K.-H. BECKER and E. STEINHARDT (MTU Motoren- und Turbinen-Union Muenchen GmbH, Munich, Federal Republic of Germany) IN: Vibration and wear in high speed rotating machinery; Proceedings of the NATO Advanced Study Institute on Vibration and Wear Damage in High Speed Rotating Machinery, Troa, Portugal, Apr. 10-22, 1989. Dordrecht, Kluwer Academic Publishers, 1990, p. 263-277. refs
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A general method has been developed for rotordynamic analysis which employs FEM codes, modal-analysis results, and a postprocessing program, with a view to advanced aircraft gas turbine design. Attention is given to the program modules, which encompass (1) a squeeze-film damper, (2) the squeeze-film forces, (3) unbalance forces, (4) gyroscopic terms, and (5) rubs. Checks conducted with the reduced structures exhibit good accuracy, especially in the critically important lower frequencies. The large variety of reduction methods allows individual treatment of each component. Due to the modular organization of the program, its capabilities can be easily extended. O.C.

A91-39590
THE CONTROL OF ROTOR VIBRATION USING SQUEEZE-FILM DAMPERS
R. HOLMES (Southampton, University, England) IN: Vibration and wear in high speed rotating machinery; Proceedings of the NATO Advanced Study Institute on Vibration and Wear Damage in High Speed Rotating Machinery, Troa, Portugal, Apr. 10-22, 1989. Dordrecht, Kluwer Academic Publishers, 1990, p. 399-412.
Copyright

A squeeze-film is an annulus of oil supplied between the outer race of a rolling-element bearing (or the bush of a sleeve bearing) and its housing. It is used as a multidirectional damping element for the control of rotor vibrations. This lecture describes the following roles of a squeeze-film damper when used in gas turbine and compressor applications as a means of reducing vibration and transmitted force due to unbalance; as an element in series with the stiffness of the bearing pedestal, and as an element in parallel with a soft spring in a vibration isolator. The effects of cavitation on performance are elucidated and the dangers of jump phenomena and subsynchronous response are discussed. Experimental work is described in which both roles of the squeeze-film damper are investigated and the results are compared with theoretical predictions. Author

A91-39694#
QUANTITATIVE ANALYSIS OF FLOW VISUALIZATIONS IN ONERA WATER TUNNELS
H. WERLE La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 6, 1990, p. 49-72. refs
Copyright

Liquid and gas tracer visualizations in the water tunnels at Chatillon can in certain cases be used in quantitative analysis of steady and unsteady flows, to specify the velocity field or profile. The examples presented in this paper illustrate some of the possibilities of these methods, which can be analyzed in greater depth now by image procession. These examples reveal the broad applications of the methods, not only to boundary layers, separations, vortices and wakes, but also to a wide variety of plane, axisymmetrical and three-dimensional flows. Author

A91-39901
LAMINAR-TURBULENT TRANSITION; PROCEEDINGS OF THE IUTAM SYMPOSIUM, ECOLE NATIONALE SUPERIEURE DE L'AERONAUTIQUE ET DE L'ESPACE, TOULOUSE, FRANCE, SEPT. 11-15, 1989
D. ARNAL, ED. (ONERA, Centre d'Etudes et de Recherches de Toulouse, France) and R. MICHEL, ED. (Ecole Nationale Superieure de l'Aeronautique et de l'Espace; ONERA, Centre d'Etudes et de Recherches de Toulouse, France) Symposium sponsored by IUTAM, DRET, ONERA, et al. Berlin and New York, Springer-Verlag, 1990, 739 p. For individual items see A91-39902 to A91-39965.
Copyright

The present conference discusses such topics in laminar-turbulent transition phenomena as the TS instability in similar boundary layer flows affected by an adverse pressure gradient, flight tests of a swept wing with suction, piezofoil arrays for airfoil flow instability investigations, the breakdown of a wave packet disturbance in a laminar boundary layer, a stability theory for chemically reacting flows, the subharmonic instability of compressible boundary layers, and wall turbulence in Blasius flow. Also discussed are stability-based methods for transition in three-dimensional flows, blunt-nosed swept supercritical LFC wings without nose flaps, the Goertler vortex instability mechanism at hypersonic speeds, wavy vortices in rotating channel flow, large-eddy simulations of mixing layers, boundary-layer tripping in supersonic flow, and visualizations of the boundary-layer transition. O.C.

A91-39902
DIALOGUE ON PROGRESS AND ISSUES IN STABILITY AND TRANSITION RESEARCH
M. V. MORKOVIN (Illinois Institute of Technology, Chicago) and E. RESHOTKO (Case Western Reserve University, Cleveland, OH) IN: Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Toulouse, France, Sept. 11-15, 1989. Berlin and New York, Springer-Verlag, 1990, p. 3-29. refs
Copyright

A development status evaluation is presented for experimental, analytical, and computational methods in flow stability and transition phenomena. Quiet supersonic wind tunnels constitute a major advancement in experimental methods, in conjunction with the simultaneous monitoring of numerous data channels. Recent analytical methods allow the characterization of convective, absolute, and global instabilities in terms of both degree of predictability and strange attractor-related behavior. Attention is given to advancements in the control of transition for drag reduction through pressure-gradient shaping, suction, cooling or heating, and wave cancellation. O.C.

A91-39904
ON THE DEVELOPMENT OF TURBULENT SPOTS IN PLANE POISEUILLE FLOW
B. KLINGMANN and P. H. ALFREDSSON (Royal Institute of Technology, Stockholm, Sweden) IN: Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Toulouse, France, Sept. 11-15, 1989. Berlin and New York, Springer-Verlag, 1990, p. 43-52. refs
Copyright

Results from an experimental study of the development of turbulent spots in plane Poiseuille flow is presented. Spots were triggered at a Reynolds number of 1600 by a loudspeaker-induced jet of high velocity. The initial disturbance was found to undergo a first stage of rapid expansion, in which sharp internal shear layers form, and subsequently break down to turbulence. This was first observed at locations away from the symmetry plane. After an initial development phase, the spot gets a self-similar shape. Oblique Tollmien-Schlichting waves were found at the wing-tips of the spot, where they reach amplitudes of more than 15 percent of the undisturbed centerline velocity. Author

A91-39909
BOUNDARY LAYER CONTROL BY A LOCAL HEATING OF THE WALL
A. V. DOVGAL', V. IA. LEVCHENKO, and V. A. TIMOFEEV (AN SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR) IN: Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Toulouse, France, Sept. 11-15, 1989. Berlin and New York, Springer-Verlag, 1990, p. 113-121. refs
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The possibility of delaying natural transition in a boundary layer flow by means of heating, in order to obtain an extended laminar region, is experimentally investigated for the cases of two-dimensional flow over a flat plate, and three-dimensional flow corresponding to the conic flow over a swept wing. An account is given of conditions under which leading-edge heating delays transition to turbulent flow. Laminarization is obtainable after a decrease of the pressure gradient on the plate, which suppresses the cross-flow instability and thereby leaves the TW wave mechanism as the sole stimulus for transition. O.C.

A91-39928
AN EVALUATION OF STABILITY-BASED METHODS FOR TRANSITION OF THREE-DIMENSIONAL FLOWS
H. H. CHEN and TUNCER CEBECI (California State University, Long Beach) IN: Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Toulouse, France, Sept. 11-15, 1989. Berlin and New York, Springer-Verlag, 1990, p. 327-336. refs
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The current eigenvalue procedures, which assume the relationship between the two wave numbers alpha and beta in the Orr-Sommerfeld equation to predict transition in three-dimensional flows, are evaluated against the saddle-point method of Cebeci and Stewartson (1980) which computed this relationship by requiring functional determinant alpha/functional determinant beta to be real. Studies for an infinite swept wing indicate that all procedures agree well with the experimental data. The results for a prolate spheroid, however, indicate that the saddle-point method leads to satisfactory results, whereas that based on an assumed relationship between alpha and beta does not. Author

A91-39945
RECEPTIVITY AND STABILITY OF THE BOUNDARY LAYER AT A HIGH TURBULENCE LEVEL
G. R. GREK, V. V. KOZLOV, and M. P. RAMAZANOV (AN SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR) IN: Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Toulouse, France, Sept. 11-15, 1989. Berlin and New York, Springer-Verlag, 1990, p. 511-521. refs
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The results of experimental studies on the boundary layer stability in gradient flow at high turbulence level are presented. The question is considered on the possibility of artificial generation, further development, and influence on laminar-turbulent transition of instability waves (Tollmien-Schlichting waves) in the boundary layer of the airfoil when the level of turbulence in the onflow constitutes 1.75 percent of the onflow velocity; the flow receptivity to disturbances and their control using the suction of the boundary layer are studied. Results of the investigations on the modeling of a turbulent spot generated from the solitary nonlinear wave packet are shown, and the characteristics of the development turbulent spot are presented at onflow turbulence degrees higher than that in earlier papers. Author

A91-39956* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
DIRECT NUMERICAL STUDY OF CROSSFLOW INSTABILITY
P. R. SPALART (NASA, Ames Research Center, Moffett Field, CA) IN: Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Toulouse, France, Sept. 11-15, 1989. Berlin and New York, Springer-Verlag, 1990, p. 621-630. refs
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Disturbances in the swept Hiemenz flow are calculated by solving the Navier-Stokes equations. The spatially-evolving base flow is treated exactly, allowing a check of the 'local' stability theories. Different types of disturbances such as random noise, waves, and wave packets, are input near the attachment line, develop in space, and exit through an outflow boundary. They all generate streamwise vortices. The effect of the Reynolds number, of the time-dependence of the noise, and of nonlinearity, are investigated. Author

A91-39959
THE EFFECT OF ISOLATED ROUGHNESS ELEMENTS ON TRANSITION IN ATTACHMENT-LINE FLOWS
D. I. A. POLL (Manchester, Victoria University, England) IN: Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Toulouse, France, Sept. 11-15, 1989. Berlin and New York, Springer-Verlag, 1990, p. 657-667. refs
Copyright

Current knowledge concerning the tripping to turbulence of an attachment-line boundary-layer flow under low-speed conditions is summarized and compared with criteria for tripping in the incompressible, zero pressure-gradient, flat-plate flow. Important similarities and significant differences are illustrated and discussed. Author

A91-40130#
THE TRANSIENT DYNAMIC PERFORMANCES OF A ROTOR-SFDB SYSTEM DURING PASSAGE THROUGH RESONANCE
JIANKANG XU (Xian Jiaotong University, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, Jan. 1991, p. A25-A30. In Chinese, with abstract in English. refs

An experimental and theoretical investigation on the transient dynamic performances of a flexible rotor-SFDB system during passage through resonance is presented. The relationship among the boundary conditions of oil-film pressure, unbalanced load, speed range, and jump phenomenon is discussed and a parameter of critical unbalanced load for jump phenomenon, mu(cr), is introduced. The parameter mu(cr) should be considered as the limit value of unbalance load of the rotor system in engineering designs. Author

A91-40157#
MODAL ANALYSIS FOR FIBRE-CARBON COMPOSITE PARTS OF AN AIRPLANE
HAIYAN FENG (Beijing Aeronautical Manufacturing Technology Research Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 11, Nov. 1990, p. A570-A572. In Chinese, with abstract in English.

The results of modal analyses and static ultrasonic tests on simple box-type aircraft structures of carbon-fiber-reinforced composite materials are summarized. The structures tested are shown in drawings, and the data are compiled in tables and briefly discussed. D.G.

A91-40234
IDENTIFICATION STRATEGIES FOR CRACK SHAPE DETERMINATION IN ROTORS [IDENTIFIKATIONSSTRATEGIEN ZUR RISSFORMBESTIMMUNG AN ROTOREN]
DIRK F. HARTMANN (Gesellschaft fuer angewandte Mathematik und Mechanik, Wissenschaftliche Jahrestagung, Hanover, Federal Republic of Germany, Apr. 8-12, 1990, Vortraege. A91-40226 16-31) Zeitschrift fuer angewandte Mathematik und Mechanik (ISSN 0044-2267), vol. 71, no. 4, 1991, p. T 139-T 141. In German. refs
Copyright

Crack shapes in laterally cracked rotors with variable bending are investigated. Strategies for parameter identification are examined. Crack shape is examined as a basis for a fracture mechanical residual life span prediction. C.D.

A91-40239
PREFERENCE FOR AN INERTIAL DEGREE OF FREEDOM DESCRIBING THE TEETER MOTION OF WINDTURBINE AND HELICOPTER ROTORS
BERNHARDT WEYH (Universitaet Duisburg-Gesamthochschule, Federal Republic of Germany) and JOHANNES ACKVA (Gesellschaft fuer angewandte Mathematik und Mechanik, Wissenschaftliche Jahrestagung, Hanover, Federal Republic of Germany, Apr. 8-12, 1990, Vortraege. A91-40226 16-31) Zeitschrift fuer angewandte Mathematik und Mechanik (ISSN 0044-2267), vol. 71, no. 4, 1991, p. T 200-T 202. refs
Copyright

When the rotating structure of a wind turbine or helicopter is coupled isotropically to the nonrotating one, time variance in the periodic coefficients of the linearized equations of motion can be eliminated by transformation of the generalized coordinates to the base of the rigid-fixed rotor. In this case, the eigenanalysis can be carried out analytically because the system has only two DOFs. In this paper, this idea is applied to two more complicated systems with teetering rotors. By considering an inertial teeter DOF, the stability investigation for both models leads to analytical expressions of limit speed which are applied to calculate stable parameter constellations for all rotor speeds of technical interest. In spite of the analytical simplifications required, a comparison with numerically calculated stability maps of nonsimple models shows excellent agreement. C.D.

A91-40241
VIBRATION BEHAVIOR OF A LABYRINTH SEAL WITH THROUGH-FLOW [SCHWINGUNGSVERHALTEN EINER DURCHSTROEMTEN LABYRINTHDICHTUNG]
BERND BEHNKE (Muenchen, Technische Universitaet, Munich, Federal Republic of Germany) (Gesellschaft fuer angewandte Mathematik und Mechanik, Wissenschaftliche Jahrestagung, Hanover, Federal Republic of Germany, Apr. 8-12, 1990, Vortraege. A91-40226 16-31) Zeitschrift fuer angewandte Mathematik und Mechanik (ISSN 0044-2267), vol. 71, no. 4, 1991, p. T 216-T 218. In German.
Copyright

The effect of through-flow on the motion of a labyrinth seal is mathematically examined. The elastic structure and the flow are modeled and coupled with each other. The eigenvalues of the whole system are used to study the effects of various parameters on the stability. C.D.

A91-40278
BALANCING OF ROTATING MACHINERY
A. G. PARKINSON (Open University, Milton Keynes, England) Institution of Mechanical Engineers, Proceedings, Part C - Journal of Mechanical Engineering Science (ISSN 0954-4062), vol. 205, no. C1, 1991, p. 53-66. refs
Copyright

An important form of vibration experienced by rotating machinery in a wide range of applications is that due to inherent unbalance. Rotating machinery may incorporate either rigid or flexible shafts and balancing procedures for both cases are discussed, but emphasis is given to a review of techniques for the high-speed balancing of flexible shafts. Reference is also made to the main International Standards in the field. Author

N91-23381# Oak Ridge National Lab., TN.
RADIOLUMINESCENT (RL) LIGHTING SYSTEM DEVELOPMENT PROGRAM
K. W. HAFF, D. J. PRUETT, D. W. RAMEY, F. J. SCHULTZ, and J. A. TOMPKINS Mar. 1991 39 p
(Contract DE-AC05-84OR-21400)
(DE91-009743; ORNL/TM-11648) Avail: NTIS HC/MF A03

The Oak Ridge National Laboratory (ORNL) has been actively engaged in the development of radioluminescent (RL) lights for the past 10 years. Primary emphasis of the program at ORNL has been on the development and improvement of gas-tube technology lights that have been manufactured by private industry for over 30 years. The primary use of these lights until this time has been exit signs with some small numbers of applications in other areas. The goal of the ORNL program was to improve the light output and brightness of the lights to an acceptable level for use as airfield marker signs, runway lights, and taxiway lights. This goal was achieved in that a greater than 100 percent light output was obtained in commercial lights purchased for the U.S. Air Force and for the State of Florida. The results are presented of the radioluminescence tests for tritiated titanium. DOE

N91-23409*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SIMULATION OF BRUSH INSERT FOR LEADING-EDGE-PASSAGE CONVECTIVE HEAT TRANSFER
R. C. HENDRICKS, M. J. BRAUN, V. CANACCI, and R. L. MULLEN (Case Western Reserve Univ., Cleveland, OH.) 1991 12 p Presented at the 4th International Symposium on Transport Phenomena in Heat and Mass Transfer, Sydney, Australia, 14-18 Jul. 1991; sponsored by New South Wales Univ.
(NASA-TM-103801; E-6093; NAS 1.15:103801) Avail: NTIS HC/MF A03 CSCL 20/4

Current and proposed high speed aircraft have high leading edge heat transfer (to 160 MW/sq m, 100 Btu/sq in/sec) and surface temperatures to 1370 K (2000 F). Without cooling, these surfaces could not survive. In one proposal the coolant hydrogen is circulated to the leading edge through a passage and returned to be consumed by the propulsion system. Simulated flow studies and visualizations have shown flow separation within the passage with a stagnation locus that isolates a zone of recirculation at the most critical portion of the passage, namely the leading edge itself. A novel method is described for mitigating the flow separation and the isolated recirculation zones by using a brush insert in the flow passage near the leading edge zone, thus providing a significant increase in heat transfer. Author

N91-23410*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
PASSIVE LAMINAR FLOW CONTROL OF CROSSFLOW VORTICITY Patent Application
BRUCE J. HOLMES, inventor (to NASA) 2 Nov. 1990 18 p
(NASA-CASE-LAR-13563-1; NAS 1.71:LAR-13563-1; US-PATENT-APPL-SN-608494) Avail: NTIS HC/MF A03 CSCL 20/4

A passive laminar flow crossflow vorticity control system includes an aerodynamic or hydrodynamic surface having geometric perturbations. The perturbations include peaks and valleys having a predetermined spacing and aligned approximately in a streamline direction to force the formation of crossflow vortices. This minimizes amplification and growth of the vortices, thus delaying transition to turbulence and reducing overall drag. NASA

N91-23411 Pennsylvania State Univ., University Park.
A COMPUTATIONALLY EFFICIENT MODELLING OF LAMINAR SEPARATION BUBBLES Ph.D. Thesis
PAOLO DINI 1990 169 p
Avail: Univ. Microfilms Order No. DA9104867

In predicting the aerodynamic characteristics of airfoils operating at low Reynolds numbers, it is often important to account for the effects of laminar (transitional) separation bubbles. Previous approaches to the modeling of this viscous phenomenon range from fast by sometimes unreliable empirical correlations for the length of the bubble and the associated increase in momentum thickness, to more accurate but significantly slower displacement thickness iteration methods employing inverse boundary layer formulations in the separated regions. Since the penalty in computational time associated with the more general methods is unacceptable for airfoil design applications, use of an accurate yet computationally efficient model is highly desirable. To this end, a semi-empirical bubble model was developed and incorporated into the Eppler and Somers airfoil design and analysis program. The generality and the efficiency were achieved by successfully approximating the local viscous/inviscid interaction, the transition location, and the turbulent reattachment process within the framework of an integral boundary-layer method. Comparisons of the predicted aerodynamic characteristics with experimental measurements for several airfoils show excellent and consistent agreement for Reynolds numbers from 2,000,000 down to 100,000. Dissert. Abstr.

N91-23413 Cornell Univ., Ithaca, NY.
BLOCK IMPLICIT MULTIGRID SOLUTION OF THE EULER EQUATIONS Ph.D. Thesis
YORAM YADLIN 1990 177 p
Avail: Univ. Microfilms Order No. DA9106233

A diagonal implicit multigrid (BDIM) scheme was developed to solve the Euler equations of inviscid, compressible flows in three-dimensions, and was implemented within the framework of block structured grids. A multigrid alternating direction implicit (ADI) scheme was developed for a single-block grid in three dimensions, using a diagonalization procedure resulting in a computationally efficient code. The scheme was applied to compute transonic flow past a swept wing and found accurate and efficient. Ways to implement the multigrid ADI scheme on block-structured grids were investigated. Two modes of multigrid cycles were developed: one in which the multigrid cycle advances concurrently on all blocks (horizontal mode) and one in which the multigrid cycle advances independently in each block (vertical mode). The efficiency and accuracy of both modes were investigate by applying the schemes to compute transonic flow past the NACA-0012 airfoil. Both modes were implemented to run on a shared-memory parallel computer. Computations of transonic flow past a swept wing illustrate the accuracy and efficiency of the scheme. Speed-up results are presented to illustrate the ability of the scheme to calculate complex flows in the short turn around time required in any design application. Dissert. Abstr.

N91-23419 Michigan Univ., Ann Arbor.
AN EXPERIMENTAL INVESTIGATION OF VORTEX PAIR INTERACTION WITH A CLEAN OR CONTAMINATED FREE SURFACE Ph.D. Thesis
AMIR HOSSEIN HIRSA 1990 148 p
Avail: Univ. Microfilms Order No. DA9034438

The interaction between a pair of trailing vortices and a free surface was studied. The vortices were produced by a submerged delta wing and a negative angle of attack. In order to isolate and study the interaction, an apparatus was built to generate reproducible vortex pairs with the same Reynolds number and Froude number as the trailing vortices. The apparatus consisted of a pair of counter rotating flaps which were moved by a computer controlled stepping motor. The vortex pairs generated with the flaps were laminar and remained laminar during the time that significant interaction with the free surface was observed. The Froude number for the vortices was low and the resulting surface deformations were small. Particle image velocimetry along with flow visualization were used to study the flow field. Striations were also observed during the interaction of the vortex pair with the free surface. The striations were found to be caused by cross-stream vortices which are stretched by the strain field between the trailing vortices and their images. Contaminants on the free surface were found to have a large influence on both the free surface deformations and the flow field of the vortices. Also, a Reynolds ridge on the free surface was observed on each side of the wake. The effect of surface contamination was studied by adding known amounts of an insoluble surfactant to the free surface. Surface depressions, termed scars, were observed above the primary vortices as well as the secondary vortices, although in the case on the secondary vortices the depression was much greater. Dissert. Abstr.

N91-23437# Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).
AERO-THERMAL INVESTIGATION OF A HIGHLY LOADED TRANSONIC LINEAR TURBINE GUIDE VANE CASCADE. A TEST CASE FOR INVISCID AND VISCOUS FLOW COMPUTATIONS
T. ARTS, M. LAMBERTDEROUVROIT, and A. W. RUTHERFORD Sep. 1990 91 p
(VKI-TN-174; ETN-91-99114) Avail: NTIS HC/MF A05

An experimental aerothermal investigation of a highly loaded transonic turbine nozzle guide vane mounted in a linear cascade arrangement is presented. The measurements were performed in a short duration isentropic light piston compression tube facility, allowing a correct simulation of Mach and Reynolds numbers as well as of the gas to wall temperature ratio compared to the values currently observed in modern aeroengines. The experimental program consisted of the following: (1) flow periodicity checks by means of wall static pressure measurements and Schlieren flow visualizations; (2) blade velocity distribution measurements by means of static pressure tappings; (3) blade convective heat transfer measurements by means of static pressure tappings; (4) blade convective heat transfer measurements by means of platinium thin films; (5) downstream loss coefficient and exit flow angle determinations by using a new fast traversing mechanism; and (6) free stream turbulence intensity and spectrum measurements. These different measurements were performed for several combinations of the free stream flow parameters looking at the relative effects on the aerodynamic blade performance and blade convective heat transfer of Mach number, Reynolds number, and freestream turbulence intensity. ESA

N91-23445# Arnold Engineering Development Center, Arnold Air Force Station, TN.
COMPUTATION OF INLET REFERENCE PLANE FLOW-FIELD FOR A SUBSCALE FREE-JET FOREBODY/INLET MODEL AND COMPARISON TO EXPERIMENTAL DATA Final Report, 1 Jan. 1989 - 31 Jul. 1990
M. D. MCCLURE and J. R. SIRBAUGH Feb. 1991 77 p Prepared in cooperation with Sverdrup Technology, Inc., Arnold AFS, TN
(AD-A232101; AEDC-TR-90-21) Avail: NTIS HC/MF A05 CSCL 20/4

The computational fluid dynamics (CFD) computer code PARC3D was used to predict the inlet reference plane (IRP) flow field for a side-mounted inlet and forebody simulator in a free jet for five different flow conditions. The calculations were performed for free-jet conditions, mass flow rates, and inlet configurations that matched the free-jet test conditions. In addition, viscous terms were included in the main flow so that the viscous free-jet shear layers emanating from the free-jet nozzle exit were modeled. A

measure of the predicted accuracy was determined as a function of free-stream Mach number, angle-of-attack, and sideslip angle. GRA

N91-23506# Central Research Inst. of Electric Power Industry, Tokyo (Japan). Energy and Environment Lab.
WATER-COOLING TECHNIQUE OF HIGH TEMPERATURE GAS TURBINE BLADE
T. SAKUMA May 1990 26 p In JAPANESE; ENGLISH summary
(DE91-764238; CRIE-T-89059) Avail: NTIS HC/MF A03

A simulation code has been developed that can simulate the thermal stress and temperature distribution of water cooled blades with a concentric tube type open thermopsyphon. The code has proven that it is possible to keep the blade temperature under 600 C and the thermal stress under 20 kg/sq mm in a gas turbine with inlet gas temperature of 1500 C. Thus, the range of blade material selections is increased and the way is opened for the simplification of cooling structures which contributes to the reduction of manufacturing costs. Furthermore, a simulation code has also been developed that can simulate the thermal efficiency of the Brayton cycle of the water cooled gas turbine. The code has proven that higher thermal efficiency for blades and nozzles is obtained by a water cooling system than by the air or steam cooling systems that are currently under development. DOE

N91-23513*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
MODAL ANALYSIS OF MULTISTAGE GEAR SYSTEMS COUPLED WITH GEARBOX VIBRATIONS
F. K. CHOY, Y. F. RUAN, Y. K. TU (Akron Univ., OH.), J. J. ZAKRAJSEK, and D. P. TOWNSEND 1991 34 p Prepared for presentation at the International Conference on Motion and Power Transmissions, Hiroshima, Japan, 24-26 Nov. 1991; sponsored in part by Japan Society of Mechanical Engineers, ASME, I.Mech.E., VDI, I.E.T., CSME
(Contract DA PROJ. 1L1-62211-A-47-A)
(NASA-TM-103797; E-6085; NAS 1.15:103797; AVSCOM-TR-90-C-033) Avail: NTIS HC/MF A03 CSCL 13/9

An analytical procedure to simulate vibrations in gear transmission systems is presented. This procedure couples the dynamics of the rotor-bearing gear system with the vibration in the gear box structure. The model synthesis method is used in solving the overall dynamics of the system, and a variable time-stepping integration scheme is used in evaluating the global transient vibration of the system. Locally each gear stage is modeled as a multimass rotor-bearing system using a discrete model. The modal characteristics are calculated using the matrix-transfer technique. The gearbox structure is represented by a finite element models, and modal parameters are solved by using NASTRAN. The rotor-gear stages are coupled through nonlinear compliance in the gear mesh while the gearbox structure is coupled through the bearing supports of the rotor system. Transient and steady state vibrations of the coupled system are examined in both time and frequency domains. A typical three-geared system is used as an example for demonstration of the developed procedure. Author

N91-23522# Israel Aircraft Industries Ltd., Ben-Gurion Airport. Ground Tests Engineering.
COMPUTERIZED SYSTEM FOR STATIC AND FATIGUE LARGE SCALE STRUCTURAL TESTS: A CASE STUDY
URI BENSHALOM May 1987 11 p
(IAITIC-87-1007; ITN-88-85006) Avail: NTIS HC/MF A03

A computerized system was developed at IAI (Israel Aircraft Industries) for large scale static and fatigue tests. The evolution of the new software system, the base-design of old systems, divergence of the original design from previous concepts, and insight gained during system development are discussed. ISA

N91-23554# Army Lab. Command, Watertown, MA. Material Technology Lab.
MODEL SENSITIVITY IN STRESS-STRENGTH RELIABILITY COMPUTATIONS Final Report
DONALD M. NEAL, WILLIAM T. MATTHEWS, and MARK G. VANGEL Jan. 1991 27 p Presented at the 36th ARD Conference on the Design Experiments in Army Research, Development and Testing
(AD-A232023; MTL-TR-91-3) Avail: NTIS HC/MF A03 CSCL 01/3

There has been a recent interest in determining high statistical reliability in risk assessment of aircraft components. This report identifies the potential consequences of incorrectly assuming a particular statistical distribution for stress or strength data used in obtaining the high reliability values. The computation of the reliability is defined as the probability of the strength being greater than the stress over the range of stress values. This method is often referred to as the stress strength model. A sensitivity analysis was performed involving a comparison of reliability results in order to evaluate the effects of assuming specific statistical distributions. Both known population distributions, and those that differed slightly from the known, were considered. Results showed substantial differences in reliability estimates even for almost nondetectable differences in the assumed distributions. These differences represent a potential problem in using the stress strength model for high reliability computations, since in practice it is impossible to ever know the exact (population) distribution. An alternative reliability computation procedure is examined involving determination of a lower bound on the reliability values using extreme value distributions. This procedure reduces the possibility of obtaining nonconservative reliability estimates. Results indicated the method can provide conservative bounds when computing high reliability. GRA

N91-24074*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
QUANTITATIVE NONDESTRUCTIVE EVALUATION: REQUIREMENTS FOR TOMORROW'S RELIABILITY
JOSEPH S. HEYMAN *In* NASA, Washington, Technology 2000, Volume 2 p 287-297 1991
Avail: NTIS HC/MF A16 CSCL 14/4

Quantitative Nondestructive Evaluation (QNDE) is the technology of measurement, analysis, and prediction of the state of material/structural systems for safety, reliability, and mission assurance. QNDE has impact on everyday life from the cars we drive, the planes we fly, the buildings we work or live in, literally to the infrastructure of our world. Here, researchers highlight some of the new sciences and technologies that are part of a safer, cost effective tomorrow. Specific technologies that are discussed are thermal QNDE of aircraft structural integrity, ultrasonic QNDE for materials characterization, and technology spinoffs from aerospace to the medical sector. In each case, examples are given of how new requirements result in enabling measurement technologies, which in turn change the boundaries of design/practice. Author

N91-24309*# Pratt and Whitney Aircraft, East Hartford, CT.
APPLICATION OF CYCLIC DAMAGE ACCUMULATION LIFE PREDICTION MODEL TO HIGH TEMPERATURE COMPONENTS
RICHARD S. NELSON *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems p 5-15 Apr. 1989
(Contract NAS3-23288)
Avail: NTIS HC/MF A12 CSCL 20/11

A high temperature, low cycle fatigue life prediction method was developed. This method, Cyclic Damage Accumulation (CDA), was developed for use in predicting the crack initiation lifetime of gas turbine engine materials, but it can be applied to other materials as well. The method is designed to account for the effects on creep-fatigue life of complex loading such as thermomechanical fatigue, hold periods, waveshapes, mean stresses, multiaxiality, cumulative damage, coatings, and environmental attack. Several

features of this model were developed to make it practical for application to actual component analysis, such as the ability to handle nonisothermal loading (including TMF), arbitrary cycle paths, and multiple damage modes. The CDA life prediction model was derived from extensive specimen tests conducted on cast nickel-base superalloy B1900 + Hf. These included both monotonic tests (tensile and creep) and strain-controlled fatigue experiments (uniaxial, biaxial, TMF, mixed creep-fatigue, and controlled mean stress). Additional specimen tests were conducted on wrought INCO 718 to verify the applicability of the final CDA model to other high-temperature alloys. The model will be available to potential users in the near future in the form of a FORTRAN-77 computer program. Author

N91-24310*# United Technologies Research Center, East Hartford, CT.
NOTCHED FATIGUE OF SINGLE CRYSTAL PWA 1480 AT TURBINE ATTACHMENT TEMPERATURES
T. G. MEYER, D. M. NISSLEY, and G. A. SWANSON (Pratt and Whitney Aircraft, East Hartford, CT.) *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems p 17-23 Apr. 1989
(Contract NAS3-23939)
Avail: NTIS HC/MF A12 CSCL 20/11

The focus is on the lower temperature, uncoated and notched features of gas turbine blades. Constitutive and fatigue life prediction models applicable to these regions are being developed. Fatigue results are presented which were obtained thus far. Fatigue tests are being conducted on PWA 1480 single crystal material using smooth strain controlled specimens and three different notched specimens. Isothermal fatigue tests were conducted at 1200, 1400, and 1600 F. The bulk of the tests were conducted at 1200 F. The strain controlled tests were conducted at 0.4 percent per second strain rate and the notched tests were cycled at 1.0 cycle per second. A clear orientation dependence is observed in the smooth strain controlled fatigue results. The fatigue lifes of the thin, mild notched specimens agree fairly well with this smooth data when elastic stress range is used as a correlating parameter. Finite element analyses were used to calculate notch stresses. Fatigue testing will continue to further explore the trends observed thus far. Constitutive and life prediction models are being developed. Author

N91-24336*# Pennsylvania State Univ., University Park. Dept. of Aerospace Engineering.
A NEW FACILITY TO STUDY THREE DIMENSIONAL VISCOUS FLOW AND ROTOR-STATOR INTERACTION IN TURBINES Progress Report
B. LAKSHMINARAYANA, C. CAMCI, and I. HALLIWELL (General Electric Co., Cincinnati, OH.) *In* NASA. Lewis Research Center, Structural Integrity and Durability of Reusable Space Propulsion Systems p 223-236 Apr. 1989
Avail: NTIS HC/MF A12 CSCL 20/4

A description of the Axial Flow Turbine Research Facility (AFTRF) being built at the Turbomachinery Laboratory of the Pennsylvania State University is presented. The purpose of the research to be performed in this facility is to obtain a better understanding of the rotor/stator interaction, three dimensional viscous flow field in nozzle and rotor blade passages, spanwise mixing and losses in these blade rows, transport of wake through rotor passage, and unsteady aerodynamics and heat transfer of rotor blade row. The experimental results will directly feed and support the analytical and the computational tool development. This large scale low speed facility is heavily instrumented with pressure and temperature probes and has provision for flow visualization and laser Doppler anemometer measurement. The facility design permits extensive use of the high frequency response instrumentation on the stationary vanes and more importantly on the rotating blades. Furthermore it facilitates detailed nozzle wake, rotor wake, and boundary layer surveys. The large size of the rig also has the advantage of operating at Reynolds numbers representative of the engine environment. Author

N91-24338*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AVERAGE-PASSAGE FLOW MODEL DEVELOPMENT
JOHN J. ADAMCZYK, MARK L. CELESTINA, TIM A. BEACH, KEVIN KIRTLEY, and MARK BARNETT (United Technologies Research Center, East Hartford, CT.) *In its* Structural Integrity and Durability of Reusable Space Propulsion Systems p 247-251 Apr. 1989
Avail: NTIS HC/MF A12 CSCL 20/4

A 3-D model was developed for simulating multistage turbomachinery flows using supercomputers. This average passage flow model described the time averaged flow field within a typical passage of a bladed wheel within a multistage configuration. To date, a number of inviscid simulations were executed to assess the resolution capabilities of the model. Recently, the viscous terms associated with the average passage model were incorporated into the inviscid computer code along with an algebraic turbulence model. A simulation of a stage-and-one-half, low speed turbine was executed. The results of this simulation, including a comparison with experimental data, is discussed. Author

N91-24475# Magnavox Co., Fort Wayne, IN.
SATURN: THE NEXT GENERATION RADIO FOR NATO
JAMES F. KEATING and THOMAS M. SCHUERMAN *In* AGARD, Electronic Counter-Counter Measures for Avionics Sensors and Communication Systems 9 p Feb. 1991
Copyright Avail: NTIS HC/MF A06; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The Second Generation Antijam Tactical UHF Radio for NATO (SATURN) system is described along with the URC-126 radio which will meet SATURN requirements when it enters production for the USAF. As its name implies, the system approach was jointly developed with NATO countries as STANAG 4372. It is designed to meet UHF Voice and data communication requirements into the next century. The URC-126 radio will replace the ARC-164, and is being developed by the USAF as part of its Have Quick antijam program. The URC-126 will be the first of several SATURN radios. It has completed Full Scale Engineering Development and Qualification Testing using the USAF Have Quick 2A Fast Frequency Hopping (FFH) mode which is a precursor of SATURN. Production radios will have the full SATURN capability. The AF has also developed and qualified the GRC-234 which uses the Have Quick 2A FFH mode. Additionally, a SATURN radio is now in development for the European Fighter Aircraft (EFA). Author

N91-24530# Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.
VISCOUS DESIGN AND ANALYSIS METHODS FOR TRANSONIC COMPRESSOR BLADING Final Technical Report, 15 May 1989 - 30 Sep. 1990
MARK DRELA 13 Feb. 1991 167 p
(Contract AF-AFOSR-0373-89; AF PROJ. 2307)
(AD-A232902; AFOSR-91-0184TR) Avail: NTIS HC/MF A08 CSCL 20/4

A viscous/inviscid computational method for the design and analysis of quasi-3D cascades has been developed. The specific application targeted is supersonic compressor blading with splitter blades, although the method is applicable to any type of cascade. The method is an extension of the ISES viscous/inviscid methodology. A streamline-based inviscid Euler formulation is fully coupled to an integral boundary layer formulation to describe the overall viscous flowfield. Rotation and streamtube contraction effects have been incorporated. The method is accurate with regards to loading and loss, and is substantially faster than equivalent Navier-Stokes solvers. Inverse design and optimization capabilities are also implemented giving an effective design/analysis system. Existing supersonic splittered cascades were investigated to determine what characteristics are desirable or undesirable in this type of blading. Sensitivity studies indicate that tangential splitter position and splitter loading details have little influence on performance. Substantial improvements are possible if the splitter is moved aft into a tandem-blade arrangement with the main blade. Comparisons between computational results

and measured data strongly suggest that traditional supersonic cascade tests involve substantial three-dimensional effects which are not correctable by measured streamtube contraction. GRA

N91-24533# California Inst. of Tech., Pasadena. Graduate Aeronautical Labs.
SIMULATION OF THE FLOW PAST AN IMPULSIVELY STARTED CYLINDER USING A DISCRETE VORTEX METHOD Final Report
FRANCOIS PEPIN 11 May 1990 152 p
(Contract AF-AFOSR-0155-88; AF PROJ. 2308)
(AD-A233066; AFOSR-91-0165TR) Avail: NTIS HC/MF A08 CSCL 20/4

Vortex methods are a powerful method for simulating incompressible flows at high Reynolds number. This work extends the basic method to include viscous effects in the presence of solid boundaries. The combination of a fully viscous vortex method with a fast parallel algorithm is used to simulate the flow past an impulsively started cylinder. Experiments have shown that this flow is characterized by the presence of secondary eddies within the main recirculating region. The numerical simulations successfully reproduced these secondary structures over a wide range of Reynolds number (Re = 550 to 9500). It was observed that the secondary phenomenon can lead to a major flow reorganization by drastically altering the transport of vorticity. At Re = 550, the vortex sheet smoothly rolls up into the primary vortex. For Re = 3000 and 9500, however, secondary eddies interfere with that process and the flux of vorticity is redirected toward the cylinder where it accumulates into a new vortical structure. The impulsive start is followed by a 1/(square root of t) singularity in the drag coefficients. The numerical simulations captured this behavior and the computed drag history for short times is in close agreement with the one predicted by a matched asymptotics analysis. GRA

N91-24551*# Pratt and Whitney Aircraft, West Palm Beach, FL. Commercial Engine Business.
COOLANT SIDE HEAT TRANSFER WITH ROTATION. TASK 3 REPORT: APPLICATION OF COMPUTATIONAL FLUID DYNAMICS
F. C. KOPPER, G. J. STURGESS, and P. DATTA Jan. 1989 91 p
(Contract NAS3-23691)
(NASA-CR-182109; NAS 1.26:182109; PWA-5930-29) Avail: NTIS HC/MF A05 CSCL 20/4

An experimental and analytical program was conducted to investigate heat transfer and pressure losses in rotating multipass passages with configurations and dimensions typical of modern turbine blades. The objective of this program is the development and verification of improved analysis methods that will form the basis for a design system that will produce turbine components with improved durability. As part of this overall program, a technique is developed for computational fluid dynamics. The specific objectives were to: select a baseline CFD computer code, assess the limitations of the baseline code, modify the baseline code for rotational effects, verify the modified code against benchmark experiments in the literature, and to identify shortcomings in the code as revealed by the verification. The Pratt and Whitney 3D-TEACH CFD code was selected as the vehicle for this program. The code was modified to account for rotating internal flows, and these modifications were evaluated for flow characteristics of those expected in the application. Results can make a useful contribution to blade internal cooling. Author

N91-24555*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
EFFECTS OF WING SWEEP ON IN-FLIGHT BOUNDARY-LAYER TRANSITION FOR A LAMINAR FLOW WING AT MACH NUMBERS FROM 0.60 TO 0.79
BIANCA TRUJILLO ANDERSON and ROBERT R. MEYER, JR. Jul. 1990 37 p Contains microfiche as supplement
(NASA-TM-101701; H-1565; NAS 1.15:101701) Avail: NTIS HC/MF A03 CSCL 20/4

The variable sweep transition flight experiment (VSTFE) was conducted on an F-14A variable sweep wing fighter to examine the effect of wing sweep on natural boundary layer transition. Nearly full span upper surface gloves, extending to 60 percent chord, were attached to the F-14 aircraft's wings. The results are presented of the glove 2 flight tests. Glove 2 had an airfoil shape designed for natural laminar flow at a wing sweep of 20 deg. Sample pressure distributions and transition locations are presented with the complete results tabulated in a database. Data were obtained at wing sweeps of 15, 20, 25, 30, and 35 deg, at Mach numbers ranging from 0.60 to 0.79, and at altitudes ranging from 10,000 to 35,000 ft. Results show that a substantial amount of laminar flow was maintained at all the wing sweeps evaluated. The maximum transition Reynolds number obtained was 18.6 x 10(exp 6) at 15 deg of wing sweep, Mach 0.75, and at an altitude of 10,000 ft. Author

N91-24556*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
EFFECTS OF WING SWEEP ON BOUNDARY-LAYER TRANSITION FOR A SMOOTH F-14A WING AT MACH NUMBERS FROM 0.700 TO 0.825
BIANCA TRUJILLO ANDERSON and ROBERT R. MEYER, JR. May 1990 48 p Contains microfiche as supplement
(NASA-TM-101712; H-1531; NAS 1.15:101712) Avail: NTIS HC/MF A03 CSCL 20/4

The results are discussed of the variable sweep transition flight experiment (VSTFE). The VSTFE was a natural laminar flow experiment flown on the swing wing F-14A aircraft. The main objective of the VSTFE was to determine the effects of wing sweep on boundary layer transition at conditions representative of transport aircraft. The experiment included the flight testing of two laminar flow wing gloves. Glove 1 was a cleanup of the existing F-14A wing. Glove 2, not discussed herein, was designed to provide favorable pressure distributions for natural laminar flow at Mach number (M) 0.700. The transition locations presented for glove 1 were determined primarily by using hot film sensors. Boundary layer rake data was provided as a supplement. Transition data were obtained for leading edge wing sweeps of 15, 20, 25, 30, and 35 degs, with Mach numbers ranging from 0.700 to 0.825, and altitudes ranging from 10,000 to 35,000 ft. Results show that a substantial amount of laminar flow was maintained at all the wing sweeps evaluated. The maximum transition Reynolds number of 13.7 x 10(exp 6) was obtained for the condition of 15 deg of sweep, M = 0.800, and an altitude of 20,000 ft. Author

N91-24583*# Iowa State Univ. of Science and Technology, Ames. Dept. of Mechanical Engineering.
SIMULATION OF A COMBINED-CYCLE ENGINE Final Report
JON VANGERPEN 10 Jun. 1991 47 p
(Contract NAG3-957)
(NASA-CR-188232; NAS 1.26:188232) Avail: NTIS HC/MF A03 CSCL 10/2

A FORTRAN computer program was developed to simulate the performance of combined-cycle engines. These engines combine features of both gas turbines and reciprocating engines. The computer program can simulate both design point and off-design operation. Widely varying engine configurations can be evaluated for their power, performance, and efficiency as well as the influence of altitude and air speed. Although the program was developed to simulate aircraft engines, it can be used with equal success for stationary and automative applications. Author

N91-24638# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Structures and Materials Panel.
ANALYTICAL QUALIFICATION OF AIRCRAFT STRUCTURES
Apr. 1991 171 p In ENGLISH and FRENCH The 70th Meeting was held in Sorrento, Italy, 1-6 Apr. 1990
(AGARD-R-772; ISBN-92-835-0603-0) Copyright Avail: NTIS HC/MF A08; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The role of structural analysis in relation to aircraft qualification procedures was addressed in order to establish guidelines for the

future and to seek out those areas where there exists a commonality of approach between nations. Topics covered include: quality assurance of software tools for structural analysis; comparison of analysis and test results; and trends in analysis for certification/certification only by analysis.

N91-24641# Wright Research Development Center, Wright-Patterson AFB, OH.
ANALYTICAL CERTIFICATION OF AIRCRAFT STRUCTURES
V. B. VENKAYYA *In* AGARD, Analytical Qualification of Aircraft Structures 14 p Apr. 1991
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Analysis is expected to play an important role in the design and validation of future aircraft structures. The need for the development of professional standards in order to implement the concept of analytical certification is presented. Standards for analysis and criteria for model definition are discussed in some detail. Author

N91-24642# Construcciones Aeronauticas S.A., Madrid (Spain). Stress Office.
NONLINEAR ANALYSIS OF COMPOSITE SHEAR WEBS WITH HOLES AND CORRELATION WITH TESTS
J. M. BLANCO SAIZ and A. BARRIO CARDABA *In* AGARD, Analytical Qualification of Aircraft Structures 17 p Apr. 1991
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Since the use of composite materials is largely extended in aircraft construction, it is necessary to develop analytical calculations to avoid the present dependency on structural tests. With that objective, a test plan of 25 representative specimens of 9 different shear webs geometries with accessing, inspecting or lightening holes, enveloping the A320 tailplane design was performed, including simulated defects and impacts for two environmental conditions. Finite element linear and nonlinear analysis, using a very refined mesh, was performed to correlate test results. Very good correlation was found even in the postbuckling behavior of the structure. This analysis allows the prediction of the postbuckling capability of these structural elements and the derivation of a failure criteria. Author

N91-24643# Beech Aircraft Corp., Wichita, KS.
BEECHCRAFT STARSHIP STRENGTH CERTIFICATION
E. H. HOOPER *In* AGARD, Analytical Qualification of Aircraft Structures 7 p Apr. 1991
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The all-composite airframe can be successfully designed and analyzed with today's technology. Simple designs using essentially monocoque techniques facilitate economical fabrication of parts and assemblies. An FAA certification program demands careful planning and coordination, especially concerning regulations, interpretations, test criteria, test plans, and test witnessing. Author

N91-24645# Fokker B.V., Schipol-Oost (Netherlands).
EVALUATION OF THE QUALIFICATION OF THE STRUCTURE OF A PASSENGER AIRCRAFT BY ANALYSIS AND FULL-SCALE TESTING
H. A. VANDULLEMEN *In* AGARD, Analytical Qualification of Aircraft Structures 12 p Apr. 1991
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On the basis of the experience with the Fokker 100 development and full-scale testing, the qualification process leading to a certified aircraft structure is reviewed. The question whether the state of the art is satisfactory or not is discussed, seen from the viewpoint of the FEM (finite element method) specialist, the manager, the structural specialist, and the authorities. Special attention is given to the problems with derivative aircraft with respect to the requirements. Computer simulation as a replacement for full-scale testing is discussed and rejected. The practical compromises in full-scale testing and FEM model verification are discussed and some crucial experiences with the test program are considered. Author

N91-24647# Royal Aerospace Establishment, Farnborough (England). Materials and Structures Dept.
THE ROLE OF STRUCTURAL ANALYSIS IN AIRWORTHINESS CERTIFICATION
P. BARTHOLOMEW *In* AGARD, Analytical Qualification of Aircraft Structures 8 p Apr. 1991
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Those uses of structural analysis which have a bearing on airworthiness are reviewed. In particular, the extent to which finite element analysis is already implicitly relied on in the context of clearance by test is considered, and factors which may be expected to lead to an increased reliance are discussed. One such factor is the increased use of the computer aided engineering (CAE) approach which changes the design process itself. An assessment is made of actions required to ensure that results of analysis provide a consistent and reliable basis for airworthiness judgement. Author

N91-24648# Canadair Ltd., Montreal (Quebec).
THE ROLE OF ANALYSIS IN THE DESIGN AND QUALIFICATION OF COMPOSITE AIRCRAFT STRUCTURES
PATRICK MCCONNELL *In* AGARD, Analytical Qualification of Aircraft Structures 12 p Apr. 1991
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Four areas of analysis in the qualification of aircraft structures made with composite materials are discussed. These areas are (1) statistics for material allowables, (2) damage tolerance modelling, (3) hygrothermal modelling, and (4) buckling of stiffened compression panels. Author

N91-24649# Dassault-Breguet Aviation, Saint Cloud (France).
INFLUENCE OF THE REFINEMENT OF STRUCTURAL CALCULATION ON AIRCRAFT QUALIFICATION PROCEDURES
C. PETIAU *In* AGARD, Analytical Qualification of Aircraft Structures 14 p Apr. 1991 In FRENCH; ENGLISH summary
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The effects of improvements of analytical methods on the process of airframe qualification are examined. Potentialities, weaknesses, and corresponding corrections are reviewed for the three main branches of structural analysis of aircraft: calculation of stress fields, determination of failure criteria in static and in fatigue, and calculation of loads, aeroelasticity, and flutter. Risks of errors are omnipresent, so the structure qualification must include a reliable process of detection and correction of errors. An organization plan for design and qualification is presented. Computer analysis plays a large role, while remaining controlled via a minimum number of relevant tests. Improvements in analytical methods assist design optimization by reducing the number of required tests and reducing the risk of failure during the main qualification tests. However, insufficient reliability of analytical methods, mainly the risk of human error, requires continued use of the main qualification tests. Author

N91-24650# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).
ANALYTICAL METHODS FOR THE QUALIFICATION OF HELICOPTER STRUCTURES
F. OCH *In* AGARD, Analytical Qualification of Aircraft Structures 14 p Apr. 1991
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Due to the increasing costs of experimental testing, analytical methods are becoming the primary means of demonstrating structural integrity, durability, and crashworthiness of helicopter structures, both for civil and military use, when representative

conditions such as temperature, moisture, cyclic loading, and impact have to be considered. The airframes of derivatives of the basic BO 105 have been qualified in the past without retesting because it could be shown that the structure conformed to those for which experience had demonstrated the structural analysis to be reliable. During the development of a composite fuselage for the BK 117, both an analytical and an experimental strength substantiation was performed, which corresponded very well and formed the basis for airworthiness qualification of this experimental helicopter under flight testing now. A large number of components in the dynamic system are designed primarily so that they will provide adequate fatigue strength, defined in terms of an endurance limit, or in terms of fatigue life. The analytical qualification of these fatigue critical structures, on the basis of measured fatigue loadings and calculated working S-N curves, is state-of-the-art in the helicopter industry. In the nonlinear domain, analytical methods are applied for highly laminated elastomeric bearings and for the crashworthiness qualification of both crushable subcomponents and complete helicopters. The results gained so far allow the application of analytical methods, partly in combination with coupon or component testing, for the qualification of helicopter structures.
Author

N91-24652*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PROBABILITY APPROACH FOR STRENGTH CALCULATIONS
CHRISTOS C. CHAMIS and T. A. CRUSE (Southwest Research Inst., San Antonio, TX.) *In* AGARD, Analytical Qualification of Aircraft Structures 13 p Apr. 1991
Copyright Avail: NTIS HC/MF A08; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive CSCL 20/11

The use of probabilistic structural analysis methods (PSAM) to predict structural reliability is the subject of an on-going NASA research program. The elements of the new technology developed to date is reported. Applications of the developed software to structural problems are demonstrated for simple validation problems and for large scale application problems. On-going research to support component and system reliability predictions suitable for analytical certification of aerospace structures is briefly reviewed.
Author

13

GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

A91-37049
US INDUSTRY ENTERS THE GREEN MAZE
BILL GREGORY Interavia Aerospace Review (ISSN 0020-6512), vol. 46, May 1991, p. 22-25.
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A review is presented of the growing number of complex and often inconsistent environmental regulations forcing the U.S. aerospace industry to spend increasingly large amounts of money to clean up past messes and to insure that future operations comply with new laws. To reduce stratospheric ozone depletion and smog generation, regulations are amended to lower volatile compounds. New aircraft construction bays include under-floor systems for recovery of corrosion inhibitors which capture emissions from paint over-spray and solvent evaporation during wing cleaning, painting and sealing. It is pointed out that company environmental policy officers are concerned by criminalization of environmental regulations; in particular it is argued that recently revised federal sentencing guidelines compound the potential severity of penalties. Water waste disposal, Clean Air Act provisions, solvents, adhesives and coatings problems and solid rocket motor waste disposal are discussed. R.E.P.

A91-37104
CLUTTER REJECTION IN DOPPLER WEATHER RADARS USED FOR AIRPORT WIND SHEAR DETECTION
JAMES E. EVANS and DANIEL HYNEK (MIT, Lexington, MA) IN: Noise and clutter rejection in radars and imaging sensors; Proceedings of the 2nd International Symposium, Kyoto, Japan, Nov. 14-16, 1989. Amsterdam, Elsevier Science Publishers, 1990, p. 275-280. FAA-supported research. refs
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Techniques for the suppression of ground and storm clutter to permit the detection of low altitude windshear by pulse Doppler radars are described. Novel features of the system include the use of clutter residue and range aliased weather echo editing maps which edit out the range-azimuth cells on a 'data adaptive basis'. Author

A91-38323
AERONAUTICAL METEOROLOGY - SAFETY AND ECONOMICS OF COMMERCIAL AIR TRANSPORTS [METEOROLOGIE AERONAUTIQUE - LA SECURITE ET L'ECONOMIE DU TRANSPORT AERIEN]
JACQUES GOAS (Meteorologie Nationale, Boulogne-Billancourt, France) Navigation (Paris) (ISSN 0028-1530), vol. 39, April 1991, p. 239-243. In French.
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The impact of meteorological parameters on the economics and safety of commercial air transportation is reviewed. Some 40 percent of fatal commercial transport accidents that have occurred since 1970 can be attributed in part to meteorological phenomena, e.g., hail, lightning, clear air turbulence, and wind shear. Consideration is given to the increasing severity of weather-related accidents in modern high-speed jet aircraft, as opposed to earlier piston engine types. Finally, the economic impact of operating high gross weight transport jet aircraft with regard to meteorological considerations, i.e., extended takeoff runs at high ambient temperatures, varying enroute climb and cruise altitudes due to changes of wind, weather and temperature, and meteorology at the destination/alternate airport, are discussed. R.E.P.

A91-38388#
THE LWC PARAMETER - SOME EXPERIMENTAL RESULTS
MAURIZIO BASSANI (Aeronautica Militare Italiana, Divisione Aerea Studi Ricerche e Sperimentazioni, Rome, Italy) Rivista di Meteorologia Aeronautica (ISSN 0035-6328), vol. 50, July-Dec. 1990, p. 141-148. refs

Analyses of four instances of icing conditions during flight tests are conducted from a meteorological standpoint. A summary of the test characteristics reported from a G222 aircraft equipped for icing certification is shown. Three events occurred near 12 UTC sounding, and one was between 12 and 18 UTC. Meteorological conditions at the time of the icing are inferred from conditions in the middle troposphere. LWC values are calculated and compared with observed data. A diffuse stability throughout the tropospheric region is indicated by the soundings, and the Appleman analysis shows favorable icing conditions. Airframe structure icing is limited to rime ice due to the lack of vertical motion. The LWC values found are shown to agree with observed values, although the value for the event corresponding to stratified cloud conditions must be linearly interpolated from time contiguous soundings. The Microcora sounding used here is shown to effectively calculate the LWC values for certain meteorological conditions. C.C.S.

N91-24170*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INTEGRATED DATA ANALYSIS OF JULY 7, 1990 MICROBURST
DAVE HINTON *In its* Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, Part 1 p 63-79 Jan. 1991
Avail: NTIS HC/MF A21 CSCL 04/2

Integrated data analysis of July 7, 1990 microburst is presented in the form of view-graphs. Topics included are: summer 1990 TDWR flight experiment; least square estimate of linear shear; event synopsis; TDWR (terminal Doppler weather radar) data analysis; citation aircraft in situ data analysis; infrared data analysis; and summary of July 7 event. Author

15

MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

A91-37584
NORMALIZED PREDICTIVE DECONVOLUTION - MULTICHANNEL TIME-SERIES APPLICATIONS TO HUMAN DYNAMICS
DANIEL J. BIEZAD (USAF, Institute of Technology, Wright-Patterson AFB, OH) IN: Control and dynamic systems. Vol. 31 - Advances in aerospace systems dynamics and control systems. Pt. 1. San Diego, CA, Academic Press, Inc., 1989, p. 193-256. refs
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The human dynamics modeling problem as it relates to aircraft is described. The normalized predictive deconvolution algorithm is derived using straightforward matrix algebra. Existence conditions are determined and translated into experimental controls applicable both to flight simulation in the laboratory and to flight testing in the air. K.K.

A91-37585
PRACTICAL CONSIDERATIONS IN OPTIMAL AND 4-DIMENSIONAL FLIGHT MANAGEMENT COMPUTATIONS
SAM LIDEN (Honeywell, Inc., Air Transport Systems Div., Phoenix, AZ) IN: Control and dynamic systems. Vol. 32 - Advances in aerospace systems dynamics and control systems. Pt. 2. San Diego, CA, Academic Press, Inc., 1990, p. 1-21. refs
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Optimization and simulation studies conducted to clarify the more pragmatic aspects of commercial aircraft flight management system (FMS) computations have indicated that the optimum arrival time and cost index can be found with adequate accuracy for cost minimization by means of a three trial pass-based procedure. While precise speed adjustment for required arrival-time predictions can be found by a simple algorithm requiring few passes to converge, wind forecast errors are found to compromise prediction accuracy; a simple method is available, however, for adjusting the flight speed by the forecast error and adjusting the prediction speed limits accordingly. Total flight cost-minimizing speed control is achievable with relatively modest FMS design modifications. O.C.

A91-37591* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
CONTROL LAW SYNTHESIS AND STABILITY ROBUSTNESS IMPROVEMENT USING CONSTRAINED OPTIMIZATION TECHNIQUES
VIVEKANANDA MUKHOPADHYAY (NASA, Langley Research Center, Hampton, VA) IN: Control and dynamic systems. Vol. 32 - Advances in aerospace systems dynamics and control systems. Pt. 2. San Diego, CA, Academic Press, Inc., 1990, p. 163-205. refs
(Contract NAG1-199; NAS1-18000)
Copyright
The present generic optimization procedure for a continuous or discrete control law (of arbitrary order), which will be applicable to a multiinput-multioutput system, is upon constraining used to satisfy conflicting design requirements on the mean-square responses and stability robustness at the plant input and output. The synthesis procedure is especially suitable for flexible airframes and large space structures modeled by a high-order state-space system of equations. Analytical expressions are obtained for the gradients of the cost function, together with design constraints on the mean-square response and minimum singular value. O.C.

A91-38234#
THE DEVELOPMENT AND RESEARCH ON CAD FOR EDUCATION ON AIRCRAFT DESIGN
MING CAO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 39, no. 446, 1991, p. 127-137. In Japanese, with abstract in English. refs
An educational computer-aided aircraft design (ECAAD) system is developed using microcomputers. The constitutive details of the program are presented with some examples. The convergence rate and accuracy of the four different optimization methods are compared and the simplex method is found to have superior characteristics to the other three. The effect of introducing a relaxation factor in optimization of the structural initial design is also discussed. Author

A91-39417#
ROBUST EIGENSTRUCTURE ASSIGNMENT WITH STRUCTURED STATE SPACE UNCERTAINTY
KENNETH M. SOBEL (City College, New York) and WANGLING YU Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, May-June 1991, p. 621-628. refs
(Contract F49620-88-C-0053)
Copyright
Recent sufficient conditions for robust stability and robust performance of linear time-invariant systems subject to structured state-space uncertainty are utilized to obtain a robust eigenstructure assignment design method. This new approach optimizes either the sufficient condition for stability or performance robustness while constraining the dominant eigenvalues to lie within chosen regions in the complex plane. This constrained optimization problem is solved by using the sequential unconstrained minimization technique with a quadratic extended interior penalty function. The use of constraints on certain eigenvector entries and the effect of these constraints on robustness and nominal performance are considered. Conservatism of the robustness conditions is reduced by simultaneously introducing a similarity transformation, a positive real diagonal weighting, and a unitary weighting into the design procedure. An example that illustrates the design of a robust eigenstructure assignment controller for a pitch pointing/vertical translation maneuver of the AFTI F-16 aircraft is presented. Author

A91-39436#
LATERAL-DIRECTION TRACKING REQUIREMENTS FROM SIMULATION DATA
MARIO INNOCENTI (Auburn University, AL) and RENZO BAVA (Aeritalia, S.p.A., Turin, Italy) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, May-June 1991, p. 701-703. refs
Copyright
The Northrop criterion (Hoh et al., 1982) used to relate flying qualities characteristics to the amount of dipole cancellation is further validated via a fixed-base simulation. Pilot comments and tracking error data are related to the analytical level boundaries provided by the criterion. A general agreement is found with the left-hand boundaries' limits, whereas the boundary position on the right-hand side of the criterion appears disputable. The validation shows the capability of the method, provided the other parameters involved in the task have level-1 values. P.D.

N91-24291# Science Applications International Corp., Fort Washington, PA. Fluid Sciences Div.
ADVANCED COMPUTATIONAL MODELS FOR ANALYZING HIGH SPEED PROPULSIVE FLOWFIELDS

SANFORD M. DASH *In* Johns Hopkins Univ., The 1990 JANNAF Propulsion Meeting, Volume 1 p 247-283 Oct. 1990
Avail: NTIS HC/MF A20

Recently developed 3-D computational models (SCRINT, PARCH, SCHAFT, CRAFT) which analyze high speed propulsive flowfield problems are described. All the models contain generalized thermochemical capabilities and advanced turbulence models, and all integrate the governing equations using implicit/strongly-conservative upwind and/or central difference numerics. The models differ with respect to discretization (finite-difference vs finite-volume), solution formulation (spatial marching parabolized Navier-Stokes (PNS), iterative PNS, time asymptotic full Navier-Stokes (FNS), and time accurate FNS), chemistry coupling (matrix-split/loosely-coupled vs large-matrix/strongly coupled), and geometric/boundary condition flexibility. The hierarchy of propulsive related problems analyzable by these models is described, with specific model formulations found to be most appropriate for specific classes of propulsive flows. Applications to both air-breathing (scramjet/gas-turbine) and rocket propulsive flowfields are described along with thoughts and experiences related to code validation, turbulence modeling, and the development of problem specific, user-friendly codes. Author

N91-24640# Aerospatiale, Toulouse (France). Structural Research and Development Dept.
VALIDATION OF IN-HOUSE AND EXTERNAL SOFTWARE SYSTEMS AT AEROSPATIALE
J. LOCATELLI and J. C. SOURISSEAU *In* AGARD, Analytical Qualification of Aircraft Structures 3 p Apr. 1991
Copyright Avail: NTIS HC/MF A08; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

In the aeronautical industry, the concept of numerical simulation is implemented, at first, in the preliminary design stage, and then during the certification activities with respect to the airworthiness regulations. This implies the development and the use of calculation software, of which it is necessary to improve the validation at different levels. The different features of these validation tests are described in the design, use, and evaluation of these software systems. The experience of the engineer then plays a major role in obtaining high quality models in the design of aircraft structures. Author

N91-24757*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ALDAS USER'S MANUAL
MICHAEL E. WATTS Apr. 1991 49 p
(NASA-TM-102831; A-90182; NAS 1.15:102831) Avail: NTIS HC/MF A03 CSCL 09/2

The Acoustic Laboratory Data Acquisition System (ALDAS) is an inexpensive, transportable means to digitize and analyze data. The system is based on the Macintosh 2 family of computers, with internal analog-to-digital boards providing four channels of simultaneous data acquisition at rates up to 50,000 samples/sec. The ALDAS software package, written for use with rotorcraft acoustics, performs automatic acoustic calibration of channels, data display, two types of cycle averaging, and spectral amplitude analysis. The program can use data obtained from internal analog-to-digital conversion, or discrete external data imported in ASCII format. All aspects of ALDAS can be improved as new hardware becomes available and new features are introduced into the code. Author

N91-24768# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
DESIGN AND IMPLEMENTATION OF REAL-TIME COMPUTER COORDINATED FORCE ACTUATING SYSTEM WITH MULTI-INPUT/OUTPUT
XIAOBIN CAI, GUANZHONG DAI, and TIESHENG JIA 7 Nov. 1990 18 p Transl. into ENGLISH from Xiyou Yu Kongzhi (Peoples Rep. of China), no. 4, 1989 p 12, 13-17
(AD-A233114; FTD-ID(RS)T-0166-90) Avail: NTIS HC/MF A03 CSCL 01/4

A design method is presented for triple point real time coordinated control loading of an electrohydraulic servosystem; with a conditional output feedback compensator, the system is relatively simple in its coordinated structure. The coordinated controller is used to alter the lift in variable sweptback wings in a loading system. As indicated by 5000 repeated tests, the method presented is feasible; the experimental results are excellent. Practical value is apparent in the designing of a stationary and moving loading type real time computer force actuating control system. GRA

N91-24796*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ENHANCING AEROPROPULSION RESEARCH WITH HIGH-SPEED INTERACTIVE COMPUTING
JOHN R. SZUCH, DALE J. ARPASI, and ANTHONY J. STRAZISAR 1991 18 p Presented at the 10th International Symposium on Air Breathing Engines, Nottingham, England, 1-6 Sep. 1991; sponsored by AIAA
(NASA-TM-104374; E-6179; NAS 1.15:104374) Avail: NTIS HC/MF A03 CSCL 09/2

NASA-Lewis has committed to a long range goal of creating a numerical test cell for aeropropulsion research and development. Efforts are underway to develop a first generation Numerical Propulsion System Simulation (NPSS). The NPSS will provide a unique capability to numerically simulate advanced propulsion systems from nose to tail. Two essential ingredients to the NPSS are: (1) experimentally validated Computational Fluid Dynamics (CFD) codes; and (2) high performing computing systems (hardware and software) that will permit those codes to be used efficiently. To this end, NASA-Lewis is using high speed, interactive computing as a means for achieving Integrated CFD and Experiments (ICE). The development is described of a prototype ICE system for multistage compressor flow physics research. Author

16

PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

A91-38688
ACOUSTICS OF UNSTEADY TRANSONIC FLOW
A. S. LYRINTZIS and Y. XUE (Minnesota, University, Minneapolis) IN: International Symposium on Nonsteady Fluid Dynamics, Toronto, Canada, June 4-7, 1990, Proceedings. New York, American Society of Mechanical Engineers, 1990, p. 187-199. refs
Copyright

Investigation of noise mechanisms due to unsteady transonic flow is important for aircraft noise reduction. In this work, the near-field impulsive noise due to transonic Blade Vortex Interaction (BVI) and oscillating flap is simulated numerically. These problems are modeled by the two-dimensional high frequency transonic small disturbance equation (VTRAN2 code). The three types of unsteady shock wave motion have been identified. Two different important disturbances exist in the pressure signal. The first disturbance is related to the fluctuating lift and the second is related to the fluctuating drag. Pressure wave signatures, noise frequency spectra, and noise directivity are investigated. Author

A91-38863
A NEW TECHNIQUE AND APPLICATION FOR NONLINEAR ACOUSTIC FATIGUE OF STIFFENED COMPOSITE PANELS
M. A. FERMAN and J. H. JACOBS (McDonnell Aircraft Co., Saint Louis, MO) IN: Vibration and behavior of composite structures; Proceedings of the Symposium, ASME Winter Annual Meeting, San Francisco, CA, Dec. 10-15, 1989. New York, American Society

of Mechanical Engineers, 1989, p. 27-33. refs
Copyright

A new solution for the prediction of nonlinear acoustic fatigue of aircraft panels is presented, emphaslzing both bidirectionally and unidirectionally stiffened panels. The response of integrally stiffened panels has been studied and a prediction methodology for nonlinear bay response and its relation to overall panel response for unimodal systems is developed. Test results indicate the accuracy for composite and metal panels, utilizing both literature and in-house data. Comparison with other prediction methods indicate that significantly more accurate results are achieved by this approach. R.E.P.

A91-39749
THE BREAKDOWN OF THE LINEARIZED THEORY AND THE ROLE OF QUADRUPOLE SOURCES IN TRANSONIC ROTOR ACOUSTICS
H. ARDAVAN (Cambridge, University, England) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 226, May 1991, p. 591-624. refs
Copyright

The retarded Green function for the linearized version of the equation of the mixed type governing the potential flow around a rotating helicopter blade or a propeller is derived, and the distinction between the various forms of the Ffowcs Williams-Hawkings equations in the supersonic regime is discussed. The singularity structure of the Green function in the supersonic regime is examined in detail. The caustic representing the envelope of the spherical wavefronts emanating from a circularly moving point source is compared and contrasted with the Mach cone of a rectilinearly moving point source, and its role in the calculation of the sound amplitude of an extended source is considered. The radial component of the gradient of the sound amplitude predicted by the Ffowcs Williams-Hawkings equation is shown to diverge as the observation point approaches the sonic cylinder from outside. The practical implications of the findings are noted, and the relationship of the singularity obtained in the study with those already found in literature is discussed. P.D.

N91-23849*# United Technologies Research Center, East Hartford, CT.
UNIFIED AEROACOUSTICS ANALYSIS FOR HIGH SPEED TURBOPROP AERODYNAMICS AND NOISE. VOLUME 2: DEVELOPMENT OF THEORY FOR WING SHIELDING Final Report
R. K. AMIET May 1991 41 p
(Contract NAS3-23720)
(NASA-CR-185192; NAS 1.26:185192) Avail: NTIS HC/MF A03 CSCL 20/1

A unified theory for aerodynamics and noise of advanced turboprops is presented. The theory and a computer code developed for evaluation at the shielding benefits that might be expected by an aircraft wing in a wing-mounted propeller installation are presented. Several computed directivity patterns are presented to demonstrate the theory. Recently with the advent of the concept of using the wing of an aircraft for noise shielding, the case of diffraction by a surface in a flow has been given attention. The present analysis is based on the case of diffraction of no flow. By combining a Galilean and a Lorentz transform, the wave equation with a mean flow can be reduced to the ordinary equation. Allowance is also made in the analysis for the case of a swept wing. The same combination of Galilean and Lorentz transforms lead to a problem with no flow but a different sweep. The solution procedures for the cases of leading and trailing edges are basically the same. Two normalizations of the solution are given by the computer program. FORTRAN computer programs are presented with detailed documentation. The output from these programs compares favorably with the results of other investigators. B.G.

N91-23850*# Hamilton Standard, Windsor Locks, CT.
UNIFIED AEROACOUSTICS ANALYSIS FOR HIGH SPEED TURBOPROP AERODYNAMICS AND NOISE. VOLUME 3: APPLICATION OF THEORY FOR BLADE LOADING, WAKES, NOISE, AND WING SHIELDING Final Report
D. B. HANSON, C. J. MCCOLGAN, R. M. LADDEN, and R. J. KLATTE May 1991 128 p
(Contract NAS3-23720)
(NASA-CR-185193; NAS 1.26:185193) Avail: NTIS HC/MF A07 CSCL 20/1

Results of the program for the generation of a computer prediction code for noise of advanced single rotation, turboprops (prop-fans) such as the SR3 model are presented. The code is based on a linearized theory developed at Hamilton Standard in which aerodynamics and acoustics are treated as a unified process. Both steady and unsteady blade loading are treated. Capabilities include prediction of steady airload distributions and associated aerodynamic performance, unsteady blade pressure response to gust interaction or blade vibration, noise fields associated with thickness and steady and unsteady loading, and wake velocity fields associated with steady loading. The code was developed on the Hamilton Standard IBM computer and has now been installed on the Cray XMP at NASA-Lewis. The work had its genesis in the frequency domain acoustic theory developed at Hamilton Standard in the late 1970s. It was found that the method used for near field noise predictions could be adapted as a lifting surface theory for aerodynamic work via the pressure potential technique that was used for both wings and ducted turbomachinery. In the first realization of the theory for propellers, the blade loading was represented in a quasi-vortex lattice form. This was upgraded to true lifting surface loading. Originally, it was believed that a purely linear approach for both aerodynamics and noise would be adequate. However, two sources of nonlinearity in the steady aerodynamics became apparent and were found to be a significant factor at takeoff conditions. The first is related to the fact that the steady axial induced velocity may be of the same order of magnitude as the flight speed and the second is the formation of leading edge vortices which increases lift and redistribute loading. Discovery and properties of prop-fan leading edge vortices were reported in two papers. The Unified AeroAcoustic Program (UAAP) capabilites are demonstrated and the theory verified by comparison with the predictions with data from tests at NASA-Lewis. Steady aerodyanmic performance, unsteady blade loading, wakes, noise, and wing and boundary layer shielding are examined. Author

N91-23851*# Hamilton Standard, Windsor Locks, CT.
UNIFIED AEROACOUSTICS ANALYSIS FOR HIGH SPEED TURBOPROP AERODYNAMICS AND NOISE. VOLUME 4: COMPUTER USER'S MANUAL FOR UAAP TURBOPROP AEROACOUSTIC CODE Final Report
R. W. MENTHE, C. J. MCCOLGAN, and R. M. LADDEN May 1991 123 p
(Contract NAS3-23720)
(NASA-CR-185194; NAS 1.26:185194) Avail: NTIS HC/MF A06 CSCL 20/1

The Unified AeroAcoustic Program (UAAP) code calculates the airloads on a single rotation prop-fan, or propeller, and couples these airloads with an acoustic radiation theory, to provide estimates of near-field or far-field noise levels. The steady airloads can also be used to calculate the nonuniform velocity components in the propeller wake. The airloads are calculated using a three dimensional compressible panel method which considers the effects of thin, cambered, multiple blades which may be highly swept. These airloads may be either steady or unsteady. The acoustic model uses the blade thickness distribution and the steady or unsteady aerodynamic loads to calculate the acoustic radiation. The users manual for the UAAP code is divided into five sections: general code description; input description; output description; system description; and error codes. The user must have access to IMSL10 libraries (MATH and SFUN) for numerous calls made for Bessel functions and matrix inversion. For plotted output users must modify the dummy calls to plotting routines included in the

code to system-specific calls appropriate to the user's installation. Author

N91-23852*# Hamilton Standard, Windsor Locks, CT.
UNIFIED AEROACOUSTICS ANALYSIS FOR HIGH SPEED TURBOPROP AERODYNAMICS AND NOISE. VOLUME 5: PROPAGATION OF PROPELLER TONE NOISE THROUGH A FUSELAGE BOUNDARY LAYER Final Report
B. MAGLIOZZI and D. B. HANSON May 1991 71 p
(Contract NAS3-23720)
(NASA-CR-185195; NAS 1.26:185195) Avail: NTIS HC/MF A04 CSCL 20/1

An analysis of tone noise propagation through a boundary layer and fuselage scattering effects was derived. This analysis is a three dimensional and the complete wave field is solved by matching analytical expressions for the incident and scattered waves in the outer flow to a numerical solution in the boundary layer flow. The outer wave field is constructed analytically from an incident wave appropriate to the source and a scattered wave in the standard Hankel function form. For the incident wave, an existing function - domain propeller noise radiation theory is used. In the boundary layer region, the wave equation is solved by numerical methods. The theoretical analysis is embodied in a computer program which allows the calculation of correction factors for the fuselage scattering and boundary layer refraction effects. The effects are dependent on boundary layer profile, flight speed, and frequency. Corrections can be derived for any point on the fuselage, including those on the opposite side from the source. The theory was verified using limited cases and by comparing calculations with available measurements from JetStar tests of model prop-fans. For the JetStar model scale, the boundary layer refraction effects produce moderate fuselage pressure reinforcements aft of and near the plane of rotation and significant attenuation forward of the plane of rotation at high flight speeds. At lower flight speeds, the calculated boundary layer effects result in moderate amplification over the fuselage area of interest. Apparent amplification forward of the plane of rotation is a result of effective changes in the source directivity due to boundary layer refraction effects. Full scale effects are calculated to be moderate, providing fuselage pressure amplification of about 5 dB at the peak noise location. Evaluation using available noise measurements was made under high-speed, high-altitude flight conditions. Comparisons of calculations made of free field noise, using a current frequency-domain propeller noise prediction method, and fuselage effects using this new procedure show good agreement with fuselage measurements over a wide range of flight speeds and frequencies. Correction factors for the JetStar measurements made on the fuselage are provided in an Appendix. Author

N91-23853# Aerospatiale, Toulouse (France).
NOISE INSIDE AIRCRAFT FUSELAGES SUBJECTED TO AIRBORNE EXCITATIONS
M. GOULAIN 1991 26 p Presented at Internoise 90, 13-15 Aug. 1990
(REPT-911-111-104; ETN-91-99268) Avail: NTIS HC/MF A03

Noises inside a cockpit and a cabin and airborne and structureborne noise are summarized with the use of graphics. The necessity of having a model of acoustic and vibration transmission is outlined. The history and complexity of models, fuselage test in laboratory and a comparison of theory and experiment are discussed. The modal method is concluded to give a good understanding of the transmission phenomena through an aircraft fuselage in a 0.15 to 2.3 frequency range. The ease of use of these methods allow parametrical studies for preliminary design for noise reduction purpose. ESA

N91-23854# European Space Agency, Paris (France).
THE PROPAGATION OF ACOUSTIC DISTURBANCES IN THE TRANSONIC FLOW FIELDS OF WINGS
RALPH VOSS (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen, Germany, F.R.) Feb. 1991 199 p Transl. into ENGLISH of Ueber die Ausbreitung Akustischer Stroerungen in Transsonischen Stroemungsfelden von Tragfluegeln (Goettingen, Fed. Republic of Germany, DLR), 1988 146 p
(ESA-TT-1126; DLR-FB-88-13; ETN-91-99312) Avail: NTIS HC/MF A09; Original German version available from DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 53.50 Deutschs marks

The propagation of small disturbances in the vicinity of transonic wings with a mixture of subsonic and supersonic regions is theoretically investigated on the basis of the geometrical acoustics approximation. Waves, beams, and the spatial density distribution of the dissipated disturbance energy are numerically calculated using a system of eighteen differential equations. The effects of various two dimensional and three dimensional fields, of the location of the source and of reflections on the wing surface are investigated. The results of the acoustic theory are used to derive a general influence function for sources of disturbance in arbitrary transonic fields. This function represents a first step towards a new surface panel method for calculating unsteady transonic flows. The acoustic results are compared with measured unsteady pressure distributions on oscillating transonic wings and with the results of a numerical field panel method. ESA

N91-24078*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A FIELD-DEPLOYABLE DIGITAL ACOUSTIC MEASUREMENT SYSTEM
DAVID L. GRAY, KENNETH D. WRIGHT, II, and WAYNE D. ROWLAND *In* NASA, Washington, Technology 2000, Volume 2 p 325-332 1991
Avail: NTIS HC/MF A16 CSCL 20/1

A field deployable digital acoustic measurement system was developed to support acoustic research programs at the Langley Research Center. The system digitizes the acoustic inputs at the microphone, which can be located up to 1000 feet from the van which houses the acquisition, storage, and analysis equipment. Digitized data from up to 12 microphones is recorded on high density 8mm tape and is analyzed post-test by a microcomputer system. Synchronous and nonsynchronous sampling is available with maximum sample rates of 12,500 and 40,000 samples per second respectively. The high density tape storage system is capable of storing 5 gigabytes of data at transfer rates up to 1 megabyte per second. System overall dynamic range exceeds 83 dB. Author

N91-24843# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Flight Mechanics Panel.
AGARD FLIGHT TEST TECHNIQUES SERIES. VOLUME 9: AIRCRAFT EXTERIOR NOISE MEASUREMENT AND ANALYSIS TECHNIQUES
H. HELLER (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick, Germany, F.R.) Apr. 1991 201 p
(AGARD-AG-300-VOL-9; ISBN-92-835-0612-X) Copyright Avail: NTIS HC/MF A10; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Testing and analysis techniques to measure aircraft noise primarily for purposes of noise certification as specified by the 'International Civil Aviation Organization', ICAO are described. The relevant aircraft noise certification standards and recommended practices are presented in detail for subsonic jet aircraft, for heavy and light propeller-driven aircraft, and for helicopters. The practical execution of conducting noise certification tests is treated in depth. The characteristics and requirements of the acoustic and non-acoustic instrumentation for data acquisition and data processing are discussed, as are the procedures to determine the special noise measures - effective perceived noise level (EPNL) and maximum overall A-weighted noise level (L sub pA,max) - that are required for the noise certification of different types of aircraft. The AGARDograph also contains an extensive, although selective, discussion of test and analysis techniques for more detailed aircraft noise studies by means of either flight experiments

or full-scale and model-scale wind tunnel experiments. Appendices provide supplementary information. Author

N91-24844*# Lockheed Aeronautical Systems Co., Burbank, CA.
LABORATORY TEST AND ACOUSTIC ANALYSIS OF CABIN TREATMENT FOR PROPFAN TEST ASSESSMENT AIRCRAFT Interim Report
H. L. KUNTZ and R. J. GATINEAU May 1991 144 p
(Contract NAS1-18036)
(NASA-CR-182075; LR-31879; NAS 1.26:182075) Avail: NTIS HC/MF A07 CSCL 20/1

An aircraft cabin acoustic enclosure, built in support of the Propfan Test Assessment (PTA) program, is described. Helmholtz resonators were attached to the cabin trim panels to increase the sidewall transmission loss (TL). Resonators (448) were located between the trim panels and fuselage shell. In addition, 152 resonators were placed between the enclosure and aircraft floors. The 600 resonators were each tuned to a 235 Hz resonance frequency. After flight testing on the PTA aircraft, the enclosure was tested in the Kelly Johnson R and D Center Acoustics Lab. Laboratory noise reduction (NR) test results are discussed. The enclosure was placed in a Gulfstream 2 fuselage section. Broadband (138 dB overall SPL) and tonal (149 dB overall SPL) excitations were used in the lab. Tonal excitation simulated the propfan flight test excitation. The fundamental tone was stepped in 2 Hz intervals from 225 through 245 Hz. The resonators increase the NR of the cabin walls around the resonance frequency of the resonator array. The effects of flanking, sidewall absorption, cabin adsorption, resonator loading of trim panels, and panel vibrations are presented. Increases in NR of up to 11 dB were measured. Author

N91-24845*# Lockheed Engineering and Sciences Co., Hampton, VA.
SIGNAL PROCESSING OF AIRCRAFT FLYOVER NOISE
JEFFREY J. KELLY May 1991 86 p
(Contract NAS1-19000)
(NASA-CR-187546; NAS 1.26:187546) Avail: NTIS HC/MF A05 CSCL 20/1

A detailed analysis of signal processing concerns for measuring aircraft flyover noise is presented. Development of a de-Dopplerization scheme for both corrected time history and spectral data is discussed along with an analysis of motion effects on measured spectra. A computer code was written to implement the de-Dopplerization scheme. Input to the code is the aircraft position data and the pressure time histories. To facilitate ensemble averaging, a uniform level flyover is considered but the code can accept more general flight profiles. The effects of spectral smearing and its removal is discussed. Using data acquired from XV-15 tilt rotor flyover test comparisons are made showing the measured and corrected spectra. Frequency shifts are accurately accounted for by the method. It is shown that correcting for spherical spreading, Doppler amplitude, and frequency can give some idea about source directivity. The analysis indicated that smearing increases with frequency and is more severe on approach than recession. Author

N91-24983*# Royal Aircraft Establishment, Farnborough (England). Space Dept.
SURFACE ACTIVATION OF CONCORDE BY BE-7 Abstract Only
P. R. TRUSCOTT, C. S. DYER, and J. C. FLATMAN *In* NASA, Langley Research Center, First LDEF Post-Retrieval Symposium Abstracts p 14 Jun. 1991
Avail: NTIS HC/MF A07 CSCL 20/8

Activation analysis of two airframe parts from Concorde aircraft has identified the presence of Be-7, a nuclide which was found by other investigators to have been collected on the forward edge of the Long Duration Exposure Facility (LDEF) structure. The results of the Concorde analysis indicate that this phenomenon is very much a surface effect, and that the areal densities of the Be-7 are comparable to those found for LDEF. The collection of Be-7 by the aircraft must be greater than in the case of LDEF (since the duration for which Concorde is accumulating the nuclide is shorter) and is of the order of 1.9 to 40 nuclei sq cm/s, depending upon assumptions made regarding the efficiency of the process which removes the radionuclide. Author

17

SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

A91-37801
THE ENGLISH SUMMER OF 1990 - FURTHER PROGRESS TOWARDS DEREGULATION OF THE AVIATION AND TRAVEL INDUSTRY
MARTIN BRIGGS (Aviation and Travel Services, Ltd., Coventry, England) Air Law (ISSN 0165-2079), vol. 16, April 1991, p. 50-62. refs
Copyright

A summary is presented of the most significant events concerning the legal and regulatory developments involving England and the EEC that occurred during 1990. Also addressed are the results of further negotiations between the governments of the U.K. and the U.S.A. on services between the two countries, and the increased security measures implemented during this period. Some of the proposals put forth by the European Commission include: a regulation on the operation of air cargo services, a draft for common rules for denied boarding compensation in scheduled air transport, and mutual acceptance of licenses for civil aviation personnel. R.E.P.

A91-38367#
THE ROLE OF ORGANIZATIONS IN PROFESSIONAL DEVELOPMENT [EL PAPEL DE LAS ASOCIACIONES EN EL DESARROLLO PROFESIONAL]
CORT DUROCHER (AIAA, Washington, DC) IN: Space Conference of the Americas, San Jose, Costa Rica, Mar. 12-16, 1990, Proceedings. Vol. 1 - Reports. San Jose, Costa Rica, Ministerio de Ciencia y Tecnologia, 1990, p. 436-440. In Spanish.

An evaluation is made of the potential contribution of such professional organizations as the American Institute of Aeronautics and Astronautics (AIAA) to the growth and dissemination of expertise in the space sciences and the aerospace industries. An account is given of the illustrative roles of AIAA in furnishing expert testimony to legislative bodies on matters pertaining to space research and development, and in the convening of conferences and exhibitions whose proceedings are subsequently published for wide circulation. AIAA's focus on the ongoing education of its members, and on the recognition of their professional achievements, is stressed. O.C.

N91-24091# Wichita State Univ., KS. Ablah Library.
AN OVERVIEW OF INFORMATION RESOURCES IN AVIATION
THOMAS G. DEPETRO *In its* Kansas Aviation Review p 21-29 1991
Avail: NTIS HC/MF A03

Information resources in aviation are produced by many sources, including publishing companies, government agencies, professional associations, research organizations, and colleges and universities. Aspects of aviation covered include: management, government regulations, air transport, engineering, technology, research and development, and applied sciences. Information is available in a number of formats including books, periodicals (magazines, journals, newspapers, newsletters), maps and charts, government documents, technical reports, professional papers, microfiche, and more recently, audio and video cassette tapes and CD/ROM and

online computer databases. This overview serves an an introduction to what information is available from key organizations and how it is distributed and organized. Author

19

GENERAL

N91-24084# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
AGARD HIGHLIGHTS 91/1, MARCH 1991
Mar. 1991 62 p
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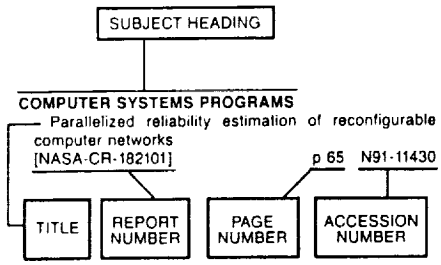
The accomplishments of AGARD are examined. Biographies are provided on the new AGARD chairman and the new director. An overview is given on the 'Danish National Day.' An article on 'Helicopters and V/STOL Aircraft - Post Development and Future Prospects' is presented. B.G.

N91-24086# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.).
ACTIVITIES REPORT OF THE DLR Annual Report 1989/90 [JAHRESBERICHT 1989/90]
THOMAS H. WEYER Sep. 1990 87 p In GERMAN
(ISSN-0938-2194; ETN-91-99252) Copyright Avail: NTIS HC/MF A05

The activities of the five research centers of the German research organization for air and space transportation during the year 1989/90 are described. Air flight, spaceceflight, and energy techniques are discussed. With regard to air flight the following research work was carried out: aerodynamic efficiency improvement, flight dynamical simulation, new helicopter technology, new propulsion unit development, air traffic, and personnel selection. Under the topic of space flight the follwing areas of research were addressed: space vehicles, rocket launchers, operating tasks for space missions, and research in space. Weightlessness research in the field of materials and bioscience, multi-axis vibration simulator development for satellites, and ozone measuring aircraft is presented. Energy techniques in the field of fossil fuel combustion, solar and hydrogen energy, and high energy lasers are discussed. ESA

Typical Subject Index Listing



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A

A-320 AIRCRAFT
A320 - First of the computer-age aircraft
p 645 A91-36354
The electrical flight control system of A320 Airbus: A fault tolerant system
[REPT-911-111-103] p 667 N91-23192

ACCELERATION (PHYSICS)
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 3: Unsteady
[AD-A233569] p 631 N91-24115

ACCEPTABILITY
Crashworthiness experiments p 638 N91-24161

ACCIDENT PREVENTION
Orientation measurements and transmission via Mode S at airports p 643 A91-38526
The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the copilot/gunner, volume 2
[AD-A232907] p 641 N91-24187
The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the copilot/gunner, volume 1
[AD-A233349] p 641 N91-24188

ACOUSTIC FATIGUE
A new technique and application for nonlinear acoustic fatigue of stiffened composite panels
p 687 A91-38863
Calculation and experimental study on sonic fatigue life of aircraft structural panels p 648 A91-40162

ACOUSTIC MEASUREMENT
A field-deployable digital acoustic measurement system p 689 N91-24078
Laboratory test and acoustic analysis of cabin treatment for propfan test assessment aircraft
[NASA-CR-182075] p 690 N91-24844

ACOUSTIC PROPERTIES
ALDAS user's manual
[NASA-TM-102831] p 687 N91-24757

ACOUSTIC RETROFITTING
Modification meets Chapter 3 standards --- re-engined Boeing 727 p 612 A91-40181

ACOUSTICS
ALDAS user's manual
[NASA-TM-102831] p 687 N91-24757

ACTIVATION ANALYSIS
Surface activation of Concorde by Be-7
p 690 N91-24983

ACTIVE CONTROL
ACT wind-tunnel experiments of a transport-type wing
p 615 A91-37772
Full-scale demonstration tests of cabin noise reduction using active vibration control p 646 A91-38549
Landing gear drop testing p 648 A91-40203
Unsteady flow structure from swept edges subjected to controlled motion
[AD-A232714] p 628 N91-23094
Integrated multidisciplinary optimization of actively controlled fiber composite wings p 667 N91-23190

ACTUATORS
Design and implementation of real-time computer coordinated force actuating system with multi-input/output
[AD-A233114] p 687 N91-24768

ADAPTIVE FILTERS
Adaptive airborne track while scan
p 642 A91-37139

ADDITIVES
Advanced thermally stable jet fuels development program annual report. Volume 3: Fuel lubricity
[AD-A232793] p 673 N91-24453

AEROACOUSTICS
Acoustics of unsteady transonic flow
p 687 A91-38688
The breakdown of the linearized theory and the role of quadrupole sources in transonic rotor acoustics
p 688 A91-39749
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 2: Development of theory for wing shielding
[NASA-CR-185192] p 688 N91-23849
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 3: Application of theory for blade loading, wakes, noise, and wing shielding
[NASA-CR-185193] p 688 N91-23850
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 4: Computer user's manual for UAAP turboprop aeroacoustic code
[NASA-CR-185194] p 688 N91-23851
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 5: Propagation of propeller tone noise through a fuselage boundary layer
[NASA-CR-185195] p 689 N91-23852

AERODYNAMIC BALANCE
Model rotor icing tests in the NASA Lewis icing research tunnel
[NASA-TM-104351] p 661 N91-23184

AERODYNAMIC CHARACTERISTICS
Forward sweep - A favorable concept for a laminar flow wing p 615 A91-37767
Moving surface boundary-layer control as applied to two-dimensional airfoils p 615 A91-37768
Equation decoupling - A new approach to the aerodynamic identification of unstable aircraft
p 664 A91-37773
Aerodynamic characteristics of slender wing-gap-body combinations p 615 A91-37777
Steady linearised aerodynamics. III - Transonic
p 620 A91-39223
Kinetic study of a homogeneous propellant primary flame, with and without additive p 671 A91-39690
Aerodynamic characteristics of scissor-wing geometries p 624 A91-40216
Aerodynamic characteristics of crescent and elliptic wings at high angles of attack p 624 A91-40219
Analysis of circular elastic membrane wings
p 625 A91-40472
Effects of canard position on the aerodynamic characteristics of a close-coupled canard configuration at low speed p 649 A91-40495
Fluid dynamics for the study of transonic flow --- Book
p 625 A91-40513
Aerodynamic preliminary analysis system 2. Part 1: Theory
[NASA-CR-182076] p 626 N91-23080
Aerodynamic preliminary analysis system 2. Part 2: User's manual
[NASA-CR-182077] p 627 N91-23081
IAI hypersonic wind tunnel
[IAITIC-87-1006] p 668 N91-23194
A computationally efficient modelling of laminar separation bubbles p 680 N91-23411
AGARD highlights 91/1, March 1991
[AGARD-HIGHLIGHTS-91/1] p 691 N91-24084
Transonic Symposium: Theory, Application and Experiment, volume 2
[NASA-CP-3020-VOL-2] p 634 N91-24132
Reynolds number effects on the transonic aerodynamics of a slender wing-body configuration
p 634 N91-24134
The effects on aerodynamic performance of designing supersonic wings for laminar flow control
[AD-A233040] p 654 N91-24197

AERODYNAMIC COEFFICIENTS
An initial investigation into methods of computing transonic aerodynamic sensitivity coefficients
[NASA-CR-188192] p 629 N91-24099

AERODYNAMIC CONFIGURATIONS
New methods in the theory of subsonic flows past thin airfoil configurations p 614 A91-36899
Aircraft repair/general aviation quick tooling
[SME PAPER EM90-178] p 611 A91-36944
The planar elements method for computing the scattering field of flight vehicle p 674 A91-37052
Instability features appearing on swept wing configurations p 622 A91-39937
Aerodynamic preliminary analysis system 2. Part 1: Theory
[NASA-CR-182076] p 626 N91-23080
Flying qualities of the X-29 forward swept wing aircraft
p 651 N91-23127
Integrated multidisciplinary optimization of actively controlled fiber composite wings p 667 N91-23190
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 1: Steady
[AD-A233482] p 631 N91-24113
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 2: User manual for VORSTAB-2
[AD-A233483] p 631 N91-24114
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 3: Unsteady
[AD-A233569] p 631 N91-24115

AERODYNAMIC DRAG
Nonlinear Aerodynamics and the Design of Wing Tips
[NASA-CR-188044] p 630 N91-24105
The computation of induced drag with nonplanar and deformed wakes p 630 N91-24106

AERODYNAMIC FORCES
Numerical study of twin-jet impingement upwash flow
p 619 A91-38736
Modeling for unsteady aerodynamics of rectangular wing in incompressible flow using step responses
p 625 A91-40473

AERODYNAMIC HEAT TRANSFER
Heat transfer in oscillating flows p 676 A91-38698
Simulation of brush insert for leading-edge-passage convective heat transfer
[NASA-TM-103801] p 679 N91-23409

AERODYNAMIC HEATING
A simplified aerothermal heating method for axisymmetric blunt bodies p 619 A91-38787

AERODYNAMIC INTERFERENCE
Deep stall of an NACA 0012 airfoil induced by periodic aerodynamic interference p 619 A91-38699
High subsonic flow about a moving spoiler identifying a novel problem of wind tunnel interference
p 619 A91-38710

Procedure for determination of three-dimensional wind tunnel wall interferences and wall adaptation in compressible subsonic flow using measured wall pressures
[DLR-FB-90-46] p 628 N91-23088

AERODYNAMIC LOADS
Stability of hingeless rotors in hover using three-dimensional unsteady aerodynamics
p 663 A91-36358
On the improvement of the supersonic lifting line theory p 614 A91-36695
Experimental investigation of loading effects on compressor trailing-edge flowfields p 615 A91-37420
Simulation of iced wing aerodynamics
[NASA-TM-104362] p 628 N91-23086

AERODYNAMIC NOISE
A study of the noise mechanisms of transonic blade-vortex interactions
[NASA-CR-188199] p 627 N91-23084
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 3: Application of theory for blade loading, wakes, noise, and wing shielding
[NASA-CR-185193] p 688 N91-23850
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 4: Computer user's manual for UAAP turboprop aeroacoustic code
[NASA-CR-185194] p 688 N91-23851
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 5: Propagation of propeller tone noise through a fuselage boundary layer
[NASA-CR-185195] p 689 N91-23852

AERODYNAMIC STABILITY
New developments in the dynamic aeroelastic stability study of rotor blades p 673 A91-36698
Simplification of nonlinear indicial response models - Assessment for the two-dimensional airfoil case
p 664 A91-37771

AERODYNAMIC STALLING
Dynamic stall of an oscillating circulation control airfoil
p 617 A91-38677
On some physical aspects of airfoil dynamic stall
p 618 A91-38686
Deep stall of an NACA 0012 airfoil induced by periodic aerodynamic interference p 619 A91-38699
Flying qualities experience on the AMX aircraft
p 650 N91-23112
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 3: Unsteady
[AD-A233569] p 631 N91-24115

AERODYNAMICS
Aerodynamic calculation of tandem wings in supersonic flow by means of SLLT p 614 A91-36724
Fluid dynamics for the study of transonic flow --- Book
p 625 A91-40513
Simulation of iced wing aerodynamics
[NASA-TM-104362] p 628 N91-23086
Icing simulation: A survey of computer models and experimental facilities
[NASA-TM-104366] p 628 N91-23087
Agility: A rational development of fundamental metrics and their relationship to flying qualities
p 651 N91-23129
A computer aided multivariable control systems design technique with application to aircraft flying qualities
[AD-A232549] p 653 N91-23144
Aerodynamics and stabilization of combustion of hydrogen jets injected into subsonic airflow
p 629 N91-23164
Passive laminar flow control of crossflow vorticity
[NASA-CASE-LAR-13563-1] p 679 N91-23410
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 1: Steady
[AD-A233482] p 631 N91-24113
Hypersonic aerodynamics fellowships
[AD-A233584] p 632 N91-24116
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 1
[NASA-CP-10060-PT-1] p 639 N91-24166
Estimate of heavy rain performance effect
p 640 N91-24182

AEROELASTICITY
New developments in the dynamic aeroelastic stability study of rotor blades p 673 A91-36698
ACT wind-tunnel experiments of a transport-type wing
p 615 A91-37772
Analytical studies on static aeroelastic behavior of forward-swept composite wing structures
p 674 A91-37774
Supersonic flutter analysis of clamped symmetric composite panels using shear deformable finite elements p 675 A91-37847
Calculation of steady and unsteady pressures on wings at supersonic speeds with a transonic small-disturbance code p 617 A91-38544
Vibration behavior of a labyrinth seal with through-flow
p 679 A91-40241
Buffet induced structural/flight-control system interaction of the X-29A aircraft
[NASA-TM-101735] p 652 N91-23133
Flow visualization study of a 1/48-scale AFTI/F111 model to investigate horizontal tail flow disturbances
[NASA-TM-101698] p 633 N91-24128

AEROLOGY
The LWC parameter - Some experimental results --- liquid water content in atmosphere p 685 A91-38388

AERONAUTICAL ENGINEERING
Aeronautical research in the United States - Challenges for the 1990's p 612 A91-38580

AERONAUTICS
The role of organizations in professional development
p 690 A91-38367

AEROSPACE INDUSTRY
US industry enters the green maze --- new environmental regulations affecting aerospace companies
p 685 A91-37049
Kansas Aviation Review
[NIAR-91-3] p 613 N91-24087

AEROSPACE MEDICINE
A test of the American Safety Flight Systems, Inc. prebreather/portable oxygen system
[AD-A232723] p 636 N91-23100
Flight mechanics/air navigation research field. A 1990 Scientific report of the German Air and Space Research Organization
[ISSN-0720-7808] p 643 N91-23103

AEROSPACE PLANES
Performance of an aerospace plane propulsion nozzle
p 615 A91-37769
Re-entry flight control of space plane using approximate perfect servo p 664 A91-37778
Improvement of atmospheric flight performance of a space vehicle through sensitivity minimization
p 664 A91-37779
Hypersonic propulsion: Past and present
p 657 N91-23148
Hypersonic propulsion: Status and challenge
p 658 N91-23153
Supersonic-hypersonic inlet studies for aerospaceplane p 659 N91-23160

AEROSPACE SCIENCES
Wright Laboratory --- review of aerospace research
p 611 A91-36351

AEROTHERMODYNAMICS
Heat transfer in oscillating flows p 676 A91-38698
Aero-thermal investigation of a highly loaded transonic linear turbine guide vane cascade. A test case for inviscid and viscous flow computations
[VKI-TN-174] p 680 N91-23437
Advanced Hypervelocity Aerophysics Facility Workshop
[NASA-CP-10031] p 669 N91-24211

AFTERBODIES
Effect of exhaust plume/afterbody interaction on installed scramjet performance p 615 A91-37770
Three-dimensional composite velocity solutions for subsonic/transonic flow p 616 A91-37841

AFTERBURNING
Turbojet potential for hypersonic flight
p 658 N91-23155

AGING (MATERIALS)
Safety of aging aircraft - Boeing programs for the 1990's
[AIAA PAPER 91-0909] p 612 A91-40563
Evaluation of automation for inspection of aging aircraft p 613 N91-24088

AH-64 HELICOPTER
The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the copilot/gunner, volume 1
[AD-A233349] p 641 N91-24188

AIR BAG RESTRAINT DEVICES
The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the copilot/gunner, volume 2
[AD-A232907] p 641 N91-24187
The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the copilot/gunner, volume 1
[AD-A233349] p 641 N91-24188

AIR BREATHING ENGINES
NASA aeropropulsion research in support of propulsion systems of the 21st century
[NASA-TM-104403] p 627 N91-23083
Airbreathing propulsion for space transport: New concepts, special problems and attempts at solutions
p 658 N91-23154
Airbreathing propulsion for transatmospheric flight
p 659 N91-23156
Design considerations for combined air breathing-rocket propulsion systems
[AIAA-90-0098] p 659 N91-23158
Supersonic-hypersonic inlet studies for aerospaceplane p 659 N91-23160
Enhancing aeropropulsion research with high-speed interactive computing
[NASA-TM-104374] p 687 N91-24796

AIR COOLING
Research on aerodynamic control of blade tip clearance flow in air-cooled turbine
[DE91-764223] p 660 N91-23182

AIR DATA SYSTEMS
Velocity sensor for an airborne optical air data system
p 655 A91-38542
Air surveying and data analysis for dynamic response of missiles at swept-back wing tip p 647 A91-40156

AIR DROP OPERATIONS
Low Altitude High Speed Cargo Parachute system development - A status report
[AIAA PAPER 91-0880] p 635 A91-40558

AIR FLOW
Numerical study of hypersonic dissociated air past blunt bodies p 616 A91-37835
Aerodynamics and stabilization of combustion of hydrogen jets injected into subsonic airflow
p 629 N91-23164

AIR INTAKES
Hypersonic Combined Cycle Propulsion
[AGARD-CP-479] p 657 N91-23147

AIR LAW
The English summer of 1990 - Further progress towards deregulation of the aviation and travel industry
p 690 A91-37801

AIR NAVIGATION
Current status and future prospects of air traffic control p 642 A91-38322
Flight mechanics/air navigation research field. A 1990 Scientific report of the German Air and Space Research Organization
[ISSN-0720-7808] p 643 N91-23103
Navigation, guidance, and trajectory optimization for hypersonic vehicles p 644 N91-23150

AIR TRAFFIC
Air travel - System relating flight safety, aircraft, and airports p 634 A91-38527
Flight mechanics/air navigation research field. A 1990 Scientific report of the German Air and Space Research Organization
[ISSN-0720-7808] p 643 N91-23103

AIR TRAFFIC CONTROL
Evolution of clutter suppression techniques for air traffic control and surveillance radar p 641 A91-37101
Clutter rejection in Doppler weather radars used for airport wind shear detection p 685 A91-37104
Track initiation using MHT in dense environments — Multiple Hypotesis Tracking p 674 A91-37141
Evaluation of the performance of a RISC based real time data processor in air traffic control radar applications p 642 A91-37145
Practical considerations in optimal and 4-dimensional flight management computations p 686 A91-37585
Air traffic control today and tomorrow
p 642 A91-38215
European studies to investigate the feasibility of using 1000 ft vertical separation minima above FL 290. I
p 642 A91-38217
Current status and future prospects of air traffic control p 642 A91-38322
Flight tests show potential benefits of data link as primary communication medium p 643 A91-38577
Near midair collisions as an indicator of general aviation collision risk p 635 N91-23096
Microwave landing system modeling with application to air traffic control
[NASA-TM-102832] p 636 N91-23099
Flight mechanics/air navigation research field. A 1990 Scientific report of the German Air and Space Research Organization
[ISSN-0720-7808] p 643 N91-23103
Airborne Collision Avoidance System (ACAS) in controlled air traffic. Aspects of reciprocal influence in Secondary Surveillance Radar (SSR) radio loads
[ETN-91-99253] p 644 N91-23105
Differential GPS terminal area test results
[AD-A232668] p 644 N91-23106
The limits of the landing process of aircraft
[DLR-FB-90-49] p 653 N91-23137
Precision runway monitor demonstration report
[AD-A232671] p 669 N91-23198
National airspace system. Communications operational concept NAS-SR-136
[DOT/FAA/SE-91/1] p 640 N91-24185

Aviation system capital investment plan
[PB91-150268] p 644 N91-24189

AIR TRANSPORTATION
The English summer of 1990 - Further progress towards deregulation of the aviation and travel industry p 690 A91-37801
Aeronautical research in the United States - Challenges for the 1990's p 612 A91-38580
Engine technology challenges for a 21st century high speed civil transport
[NASA-TM-104363] p 636 N91-23098
Activities report of the DLR
[ISSN-0938-2194] p 691 N91-24086
An overview of information resources in aviation p 690 N91-24091

AIRBORNE EQUIPMENT
Functional-adaptive data processing in airborne radio navigation and landing systems p 643 A91-39187
Advanced airborne oxygen sensors p 655 A91-39387
Airborne Collision Avoidance System (ACAS) in controlled air traffic. Aspects of reciprocal influence in Secondary Surveillance Radar (SSR) radio loads
[ETN-91-99253] p 644 N91-23105
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 2
[NASA-CP-10060-PT-2] p 636 N91-24140
CLASS: Coherent Lidar Airborne Shear Sensor. Windshear avoidance
[LMSC-F-415048] p 636 N91-24141
Clutter modeling of the Denver Airport and surrounding areas p 638 N91-24152
Radar simulation program upgrade and algorithm development p 638 N91-24153
Airborne radar simulation studies of the Denver July 11, 1988 microburst p 638 N91-24155
Description, characteristics and testing of the NASA airborne radar p 638 N91-24156
Integration of weather sensing devices p 639 N91-24174
NASA Langley flight test program p 639 N91-24175
TDWR information on the flight deck p 640 N91-24176
Orlando experiment p 640 N91-24177

AIRBORNE SURVEILLANCE RADAR
Adaptive airborne track while scan p 642 A91-37139

AIRBORNE/SPACEBORNE COMPUTERS
A320 - First of the computer-age aircraft p 645 A91-36354
Along for the ride? --- computer-automated aviation overview p 656 A91-40550
The electrical flight control system of A320 Airbus: A fault tolerant system
[REPT-911-111-103] p 667 N91-23192

AIRCRAFT ACCIDENTS
Aeronautical meteorology - Safety and economics of commercial air transports p 685 A91-38323
Orientation measurements and transmission via Mode S at airports p 643 A91-38526
Near midair collisions as an indicator of general aviation collision risk p 635 N91-23096
The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the copilot/gunner, volume 2
[AD-A232907] p 641 N91-24187

AIRCRAFT ANTENNAS
Characteristics of the reception by the antenna systems of a descending aircraft of signals from radio-beacon landing systems p 642 A91-37200
Development of B-1 antenna measurement test bed p 668 A91-37881

AIRCRAFT COMMUNICATION
Current status and future prospects of air traffic control p 642 A91-38322
Flight tests show potential benefits of data link as primary communication medium p 643 A91-38577
National airspace system. Communications operational concept NAS-SR-136
[DOT/FAA/SE-91/1] p 640 N91-24185

AIRCRAFT COMPARTMENTS
Full-scale demonstration tests of cabin noise reduction using active vibration control p 646 A91-38549
Canopy breaking system for non-delay pilot rescue p 647 A91-39398
Application of acoustically treated honeycomb sandwich panels in noise control of aircraft cabin p 648 A91-40160

AIRCRAFT CONFIGURATIONS
A study on sonic load of the vertical tail of F-7 aircraft p 648 A91-40171
Aerodynamic characteristics of scissor-wing geometries p 624 A91-40216
Integration of handling quality aspects into the aerodynamic design of modern unstable fighters p 667 N91-23125
A review of high angle of attack requirements for combat aircraft p 651 N91-23130
X-31A at first flight p 651 N91-23131
Navigation, guidance, and trajectory optimization for hypersonic vehicles p 644 N91-23150
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 1: Steady
[AD-A233482] p 631 N91-24113
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 2: User manual for VORSTAB-2
[AD-A233483] p 631 N91-24114

AIRCRAFT CONSTRUCTION MATERIALS
Metal matrix composite vertical tail fabrication
[SME PAPER EM90-438] p 611 A91-36875
Modal analysis for fibre-carbon composite parts of an airplane p 679 A91-40157
Calculation and experimental study on sonic fatigue life of aircraft structural panels p 648 A91-40162
NKK premium quality titanium master alloy p 672 A91-40425
Observatory of new materials. Evolution perspectives for the materials used in civil transportation aircraft
[REPT-911-111-107] p 672 N91-23248

AIRCRAFT CONTROL
Normalized predictive deconvolution - Multichannel time-series applications to human dynamics p 686 A91-37584
Methodology for the analytical assessment of aircraft handling qualities p 664 A91-37597
ACT wind-tunnel experiments of a transport-type wing p 615 A91-37772
Effects of horizontal tail ice on longitudinal aerodynamic derivatives p 665 A91-38547
Evolution of airplane stability and control - A designer's viewpoint p 665 A91-39401
Real time estimation of aircraft angular attitude
[IAITIC-87-1004] p 649 N91-23107
Flying Qualities
[AGARD-CP-508] p 649 N91-23108
MIL-STD-1797 is not a cookbook p 650 N91-23111
Handling qualities guidelines for the design of fly-by-wire flight control systems for transport aircraft p 667 N91-23119
Determination of decision-height windows for decelerating IMC approaches in helicopters p 667 N91-23124
The electrical flight control system of A320 Airbus: A fault tolerant system
[REPT-911-111-103] p 667 N91-23192

AIRCRAFT DESIGN
Identification of pilot-vehicle dynamics from simulation and flight test p 664 A91-37598
Design of aircraft wings subjected to gust loads - A safety index based approach p 675 A91-37851
Advanced aircraft secondary power system design p 656 A91-38007
The development and research on CAD for education on aircraft design p 686 A91-38234
Aircraft design for maintainability p 612 A91-38546
Optimization of rotor performance in hover using a free wake analysis p 646 A91-38548
Vibration problems in an aircraft design p 648 A91-40165
Tiltrotor developments p 612 A91-40180
Effects of canard position on the aerodynamic characteristics of a close-coupled canard configuration at low speed p 649 A91-40495
Safety of aging aircraft - Boeing programs for the 1990's
[AIAA PAPER 91-0909] p 612 A91-40563
The art of flying qualities testing p 649 N91-23109
Integration of handling quality aspects into the aerodynamic design of modern unstable fighters p 667 N91-23125
Agility: A rational development of fundamental metrics and their relationship to flying qualities p 651 N91-23129
A review of high angle of attack requirements for combat aircraft p 651 N91-23130
X-31A at first flight p 651 N91-23131
A new architecture and expert system for aircraft design synthesis p 652 N91-23132
Application of multidisciplinary optimization methods to the design of a supersonic transport
[NASA-TM-104073] p 652 N91-23135
Design and construction of a composite airframe for UAV research
[AD-A232422] p 653 N91-23143
A computer aided multivariable control systems design technique with application to aircraft flying qualities
[AD-A232549] p 653 N91-23144
IAI hypersonic wind tunnel
[IAITIC-87-1006] p 668 N91-23194
Nonlinear Aerodynamics and the Design of Wing Tips
[NASA-CR-188044] p 630 N91-24105
A general multiblock Euler code for propulsion integration. Volume 1: Theory document
[NASA-CR-187484-VOL-1] p 632 N91-24120
A general multiblock Euler code for propulsion integration. Volume 3: User guide for the Euler code
[NASA-CR-187484-VOL-3] p 632 N91-24122
Transonic Symposium: Theory, Application and Experiment, volume 2
[NASA-CP-3020-VOL-2] p 634 N91-24132
Laminar-flow flight experiments p 634 N91-24135
Computational support of the X-29A Advanced Technology Demonstrator flight experiment p 653 N91-24137
Results of correlations for transition location on a clean-up glove installed on an F-14 aircraft and design studies for a laminar glove for the X-29 aircraft accounting for spanwise pressure gradient p 654 N91-24138
Variable Sweep Transition Flight Experiment (VSTFE): Unified Stability System (USS). Description and users' manual
[NASA-CR-181918] p 634 N91-24139
Lightning protection requirements for aircraft: A proposed specification
[RAE-TM-FS(F)-632-ISSUE-1-R] p 641 N91-24186
A system approach to aircraft optimization
[NASA-TM-104074] p 654 N91-24196
The effects on aerodynamic performance of designing supersonic wings for laminar flow control
[AD-A233040] p 654 N91-24197
Evaluation of cloud detection instruments and performance of laminar-flow leading-edge test articles during NASA Leading-Edge Flight-Test Program
[NASA-TP-2888] p 655 N91-24199
Analytical Qualification of Aircraft Structures
[AGARD-R-772] p 683 N91-24638
Validation of in-house and external software systems at Aerospatiale p 687 N91-24640
Analytical certification of aircraft structures p 684 N91-24641

AIRCRAFT ENGINES
Automated CAD design for sculptured airfoil surfaces
[SME PAPER MS90-744] p 673 A91-36943
On digital electronic control system of aircraft engine p 657 A91-38209
Water droplet impingement on airfoils and aircraft engine inlets for icing analysis p 634 A91-38543
Design and development of aviation gas turbine engines --- Russian book p 657 A91-39201
Modification meets Chapter 3 standards --- re-engined Boeing 727 p 612 A91-40181
Vectored propulsion, supermaneuverability and robot aircraft --- Book p 649 A91-40501
NASA aeropropulsion research in support of propulsion systems of the 21st century
[NASA-TM-104403] p 627 N91-23083
Engine technology challenges for a 21st century high speed civil transport
[NASA-TM-104363] p 636 N91-23098
Fuel-rich, catalytic reaction experimental results
[NASA-TM-104423] p 662 N91-24203
Small Engine Component Technology (SECT)
[NASA-CR-175078] p 662 N91-24205
Small Engine Component Technology (SECT) study
[NASA-CR-175081] p 663 N91-24207

AIRCRAFT FUELS
Detection of traces of water in aviation kerosenes by gas chromatography p 670 A91-37182
Commercial aircraft fuel efficiency potential through 2010 p 645 A91-38127
Methanol - An environmentally attractive alternative commercial aviation fuel p 670 A91-38129

AIRCRAFT GUIDANCE
Navigation, guidance, and trajectory optimization for hypersonic vehicles p 644 N91-23150

AIRCRAFT HAZARDS
Icing simulation: A survey of computer models and experimental facilities
[NASA-TM-104366] p 628 N91-23087
Near midair collisions as an indicator of general aviation collision risk p 635 N91-23096
Signal processing techniques for clutter filtering and wind shear detection p 638 N91-24154
Lightning protection requirements for aircraft: A proposed specification
[RAE-TM-FS(F)-632-ISSUE-1-R] p 641 N91-24186

AIRCRAFT INDUSTRY
Estimating fixed and variable costs of airframe manufacturers
[AD-A232661] p 613 N91-23077
Integration of propulsive systems: Selection and compromise
[REPT-911-111-101] p 661 N91-23187

Some analysis of decision-making in the test manufacture of military aircraft
[AD-A233111] p 613 N91-24093

AIRCRAFT INSTRUMENTS
Radiation transmission in adverse weather p 675 A91-37880
Aircraft Command in Emergency Situations (ACES). Phase 1: Concept development
[DOT/FAA/CT-90/21] p 636 N91-23097
An engineering study of altitude determination deficiencies of the Service Aircraft Instrumentation Package (SAIP)
[AD-A232055] p 656 N91-23145

AIRCRAFT LANDING
Characteristics of the reception by the antenna systems of a descending aircraft of signals from radio-beacon landing systems p 642 A91-37200
The limits of the landing process of aircraft
[DLR-FB-90-49] p 653 N91-23137
LIDAR studies on microbursts p 639 N91-24167

AIRCRAFT MAINTENANCE
Aircraft repair/general aviation quick tooling
[SME PAPER EM90-178] p 611 A91-36944
Aircraft design for maintainability p 612 A91-38546

AIRCRAFT MANEUVERS
The influence of altitude and speed variations over the aircraft flight control response during the longitudinal nonlinear manoeuvres p 664 A91-36722
Helicopter in-flight stores jettison p 671 A91-39389
Vectored propulsion, supermaneuverability and robot aircraft --- Book p 649 A91-40501
Agility: A rational development of fundamental metrics and their relationship to flying qualities p 651 N91-23129
Status of Sundstrand research p 640 N91-24183

AIRCRAFT MODELS
Safety of aging aircraft - Boeing programs for the 1990's
[AIAA PAPER 91-0909] p 612 A91-40563
The costs and benefits of aircraft availability
[AD-A232660] p 613 N91-23076
Navigation, guidance, and trajectory optimization for hypersonic vehicles p 644 N91-23150
Model rotor icing tests in the NASA Lewis icing research tunnel
[NASA-TM-104351] p 661 N91-23184

AIRCRAFT NOISE
Full-scale demonstration tests of cabin noise reduction using active vibration control p 646 A91-38549
A study of the noise mechanisms of transonic blade-vortex interactions
[NASA-CR-188199] p 627 N91-23084
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 2: Development of theory for wing shielding
[NASA-CR-185192] p 688 N91-23849
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 3: Application of theory for blade loading, wakes, noise, and wing shielding
[NASA-CR-185193] p 688 N91-23850
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 4: Computer user's manual for UAAP turboprop aeroacoustic code
[NASA-CR-185194] p 688 N91-23851
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 5: Propagation of propeller tone noise through a fuselage boundary layer
[NASA-CR-185195] p 689 N91-23852
Noise inside aircraft fuselages subjected to airborne excitations
[REPT-911-111-104] p 689 N91-23853
A field-deployable digital acoustic measurement system p 689 N91-24078
AGARD flight test techniques series. Volume 9: Aircraft exterior noise measurement and analysis techniques
[AGARD-AG-300-VOL-9] p 689 N91-24843
Laboratory test and acoustic analysis of cabin treatment for propfan test assessment aircraft
[NASA-CR-182075] p 690 N91-24844
Signal processing of aircraft flyover noise
[NASA-CR-187546] p 690 N91-24845

AIRCRAFT PARTS
Modal analysis for fibre-carbon composite parts of an airplane p 679 A91-40157

AIRCRAFT PERFORMANCE
Long-range aircraft are in demand p 611 A91-36353
Methodology for the analytical assessment of aircraft handling qualities p 664 A91-37597
Aeronautical research in the United States - Challenges for the 1990's p 612 A91-38580
Aircraft performance p 649 A91-40511
Flying Qualities
[AGARD-CP-508] p 649 N91-23108
MIL-STD-1797 is not a cookbook p 650 N91-23111
Development of MIL-8785C into a handling qualities specification for a new European fighter aircraft p 666 N91-23114
Do civil flying qualities requirements address military missions for off-the-shelf procurement p 650 N91-23115
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 1
[NASA-CP-10060-PT-1] p 639 N91-24166
Estimate of heavy rain performance effect p 640 N91-24182

AIRCRAFT PILOTS
Identification of pilot-vehicle dynamics from simulation and flight test p 664 A91-37598
Canopy breaking system for non-delay pilot rescue p 647 A91-39398

AIRCRAFT POWER SUPPLIES
Advanced aircraft secondary power system design p 656 A91-38007
Aircraft electrical system computer simulation p 657 A91-38037

AIRCRAFT PRODUCTION
CAPP imitative system of aircraft assembly --- Computer Aided Process Planning p 611 A91-37061

AIRCRAFT RELIABILITY
Flexure vibration test method of aviation tube p 648 A91-40172
The certification of the aircraft integrated propulsive system
[REPT-911-111-102] p 661 N91-23188
The role of structural analysis in airworthiness certification p 684 N91-24647
Analytical methods for the qualification of helicopter structures p 684 N91-24650

AIRCRAFT SAFETY
Aeronautical meteorology - Safety and economics of commercial air transports p 685 A91-38323
Orientation measurements and transmission via Mode S at airports p 643 A91-38526
Air travel - System relating flight safety, aircraft, and airports p 634 A91-38527
Safety of aging aircraft - Boeing programs for the 1990's
[AIAA PAPER 91-0909] p 612 A91-40563
Near midair collisions as an indicator of general aviation collision risk p 635 N91-23096
Aircraft Command in Emergency Situations (ACES). Phase 1: Concept development
[DOT/FAA/CT-90/21] p 636 N91-23097
The art of flying qualities testing p 649 N91-23109
Program plans for aviation safety research
[NIAR-90-32] p 638 N91-24157
NASA Langley flight test program p 639 N91-24175
The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the copilot/gunner, volume 2
[AD-A232907] p 641 N91-24187

AIRCRAFT SPECIFICATIONS
Flying Qualities
[AGARD-CP-508] p 649 N91-23108
MIL-STD-1797 is not a cookbook p 650 N91-23111
Flying qualities experience on the AMX aircraft p 650 N91-23112
The development of alternate criteria for FBW handling qualities p 666 N91-23113
Development of MIL-8785C into a handling qualities specification for a new European fighter aircraft p 666 N91-23114
Do civil flying qualities requirements address military missions for off-the-shelf procurement p 650 N91-23115

AIRCRAFT STABILITY
Equation decoupling - A new approach to the aerodynamic identification of unstable aircraft p 664 A91-37773
Improvement of atmospheric flight performance of a space vehicle through sensitivity minimization p 664 A91-37779
Effects of horizontal tail ice on longitudinal aerodynamic derivatives p 665 A91-38547
Evolution of airplane stability and control - A designer's viewpoint p 665 A91-39401
The art of flying qualities testing p 649 N91-23109
The development of alternate criteria for FBW handling qualities p 666 N91-23113
Integration of handling quality aspects into the aerodynamic design of modern unstable fighters p 667 N91-23125
B-1B high AOA testing in the evaluation of a stall inhibitor system p 651 N91-23126
Evaluation techniques for highly augmented aircraft
[DLR-FB-90-35] p 667 N91-23191

AIRCRAFT STRUCTURES
Automatic aircraft paint stripping
[SME PAPER MS90-280] p 611 A91-36895
Robotic sensors for aircraft paint stripping
[SME PAPER MS90-282] p 673 A91-36896
The introduction of off-line programming techniques for the robotic assembly of aircraft structures
[SME PAPER MS90-276] p 611 A91-36898
A new technique and application for nonlinear acoustic fatigue of stiffened composite panels p 687 A91-38863
Sensitivity analysis, optimization, and data support in finite element systems p 677 A91-39230
Identification of nacelle modes from airplane GVT results p 648 A91-40170
Computerized system for static and fatigue large scale structural tests: A case study
[IAITIC-87-1007] p 681 N91-23522
Quantitative nondestructive evaluation: Requirements for tomorrow's reliability p 681 N91-24074
Evaluation of automation for inspection of aging aircraft p 613 N91-24088
Program plans for aviation safety research
[NIAR-90-32] p 638 N91-24157
Feasibility study in crack detection in aircraft stiffened panels by pulse probing and deconvolution p 654 N91-24158
Bonded/fusion repair of aircraft structures p 613 N91-24160
Mechanical paint removal techniques for composite aircraft p 613 N91-24163
Analytical Qualification of Aircraft Structures
[AGARD-R-772] p 683 N91-24638
Validation of in-house and external software systems at Aerospatiale p 687 N91-24640
Analytical certification of aircraft structures p 684 N91-24641
Nonlinear analysis of composite shear webs with holes and correlation with tests p 684 N91-24642
Evaluation of the qualification of the structure of a passenger aircraft by analysis and full-scale testing p 684 N91-24645
The role of analysis in the design and qualification of composite aircraft structures p 684 N91-24648
Probability approach for strength calculations p 685 N91-24652

AIRCRAFT SURVIVABILITY
Toward enhanced fighter combat effectiveness p 645 A91-37050

AIRCRAFT WAKES
A vortex panel method for calculating aircraft downwash on parachute trajectories
[AIAA PAPER 91-0875] p 626 A91-40557
An experimental study of an axisymmetric turbulent boundary layer disturbed by a periodic freestream p 626 N91-23078
Aircraft wake vortices: An assessment of the current situation
[AD-A231658] p 626 N91-23079
A vortex panel method for calculating aircraft downwash on parachute trajectories
[DE91-009764] p 627 N91-23085
Aircraft wake vortices: An annotated bibliography (1923-1990)
[AD-A233161] p 631 N91-24111

AIRFOIL FENCES
Tip vortex/airfoil interaction for a low Reynolds number canard/wing configuration p 617 A91-38545

AIRFOIL OSCILLATIONS
Simplification of nonlinear indicial response models - Assessment for the two-dimensional airfoil case p 664 A91-37771
On some physical aspects of airfoil dynamic stall p 618 A91-38686
Further experiments on vortex formation around an oscillating and translating airfoil at large incidences p 620 A91-39738
Investigations on flow instabilities on airfoils by means of piezofoil-arrays p 621 A91-39911
Transonic flutter analysis of 2-D airfoils with 2 degrees of freedom p 665 A91-40169
Airfoil transition and separation studies using an infrared imaging system p 624 A91-40215

AIRFOIL PROFILES
Automated CAD design for sculptured airfoil surfaces
[SME PAPER MS90-744] p 673 A91-36943
Experimental investigation of loading effects on compressor trailing-edge flowfields p 615 A91-37420
Moving surface boundary-layer control as applied to two-dimensional airfoils p 615 A91-37768
Water droplet impingement on airfoils and aircraft engine inlets for icing analysis p 634 A91-38543
Airfoil design method using the Navier-Stokes equations p 646 A91-38550
Unsteady flow past an airfoil pitched at constant rate p 617 A91-38679

Unsteady separation on an impulsively set into motion Carafoli airfoil p 618 A91-38694
Deep stall of an NACA 0012 airfoil induced by periodic aerodynamic interference p 619 A91-38699
Steady linearised aerodynamics. III - Transonic p 620 A91-39223
Calculation of low Reynolds number flows at high angles of attack p 624 A91-40218

AIRFOILS
Cell centered and cell vertex multigrid schemes for the Navier-Stokes equations p 674 A91-37834
Airfoil design method using the Navier-Stokes equations p 646 A91-38550
Receptivity and stability of the boundary layer at a high turbulence level p 678 A91-39945
Icing simulation: A survey of computer models and experimental facilities [NASA-TM-104366] p 628 N91-23087
Advanced ice protection systems test in the NASA Lewis icing research tunnel [NASA-TM-103757] p 661 N91-23183
A computationally efficient modelling of laminar separation bubbles p 680 N91-23411
The NASA Langley laminar-flow-control experiment on a swept, supercritical airfoil: Suction coefficient analysis [NASA-TM-4267] p 629 N91-24098
Laminar-flow wind tunnel experiments p 634 N91-24136

AIRFRAMES
Accent on hypersonic p 669 A91-36625
Estimating fixed and variable costs of airframe manufacturers [AD-A232661] p 613 N91-23077
Application of multidisciplinary optimization methods to the design of a supersonic transport [NASA-TM-104073] p 652 N91-23135
Design and construction of a composite airframe for UAV research [AD-A232422] p 653 N91-23143
Beechcraft starship strength certification p 684 N91-24643
Influence of the refinement of structural calculation on aircraft qualification procedures p 684 N91-24649
Analytical methods for the qualification of helicopter structures p 684 N91-24650

AIRLINE OPERATIONS
Evaluation of cloud detection instruments and performance of laminar-flow leading-edge test articles during NASA Leading-Edge Flight-Test Program [NASA-TP-2888] p 655 N91-24199

AIRPORTS
Orientation measurements and transmission via Mode S at airports p 643 A91-38526
Air travel - System relating flight safety, aircraft, and airports p 634 A91-38527
Literature review on geotextiles to improve pavements for general aviation airports [AD-A232871] p 669 N91-23199
Saberliner flight test for airborne wind shear forward looking detection and avoidance radar systems p 637 N91-24149
Clutter modeling of the Denver Airport and surrounding areas p 638 N91-24152
Airborne radar simulation studies of the Denver July 11, 1988 microburst p 638 N91-24155
MLS mathematical model validation study using airborne MLS data from Atlantic City International Airport Boeing 727 elevation shadowing flight tests [DOT-FAA/CT-TN90/55] p 644 N91-24190

AIRSPACE
Aviation system capital investment plan [PB91-150268] p 644 N91-24189

AIRSPEED
A new method for estimating airspeed, attack angle and sideslip angle p 664 A91-37051
Airblast atomization at conditions of low air velocity p 674 A91-37410
Velocity sensor for an airborne optical air data system p 655 A91-38542

ALGORITHMS
An initial investigation into methods of computing transonic aerodynamic sensitivity coefficients [NASA-CR-188192] p 629 N91-24099
Saberliner flight test for airborne wind shear forward looking detection and avoidance radar systems p 637 N91-24149
Radar simulation program upgrade and algorithm development p 638 N91-24153
Simulation of the flow past an impulsively started cylinder using a discrete vortex method [AD-A233066] p 683 N91-24533

ALTITUDE
An engineering study of altitude determination deficiencies of the Service Aircraft Instrumentation Package (SAIP) [AD-A232055] p 656 N91-23145

ALTITUDE CONTROL
Real time estimation of aircraft angular attitude [IAITIC-87-1004] p 649 N91-23107

ALUMINIDES
Fatigue crack growth in monolithic titanium aluminides p 670 A91-38809
Titanium aluminides for aerospace applications p 671 A91-39302

AMBULANCES
Air ambulance helicopter operational analysis [DOT/FAA/RD-91/7] p 652 N91-23134

ANALOG TO DIGITAL CONVERTERS
ALDAS user's manual [NASA-TM-102831] p 687 N91-24757

ANGLE OF ATTACK
A new method for estimating airspeed, attack angle and sideslip angle p 664 A91-37051
Stream functions for the hypersonic flow around quasi-pointed slender bodies at low angles of attack p 621 A91-39832
Synchronous iterative method for computation of vortex flows at high angles of attack p 624 A91-40126
Airfoil transition and separation studies using an infrared imaging system p 624 A91-40215
Calculation of low Reynolds number flows at high angles of attack p 624 A91-40218
Aerodynamic characteristics of crescent and elliptic wings at high angles of attack p 624 A91-40219
B-1B high AOA testing in the evaluation of a stall inhibitor system p 651 N91-23126
A review of high angle of attack requirements for combat aircraft p 651 N91-23130
Buffet induced structural/flight-control system interaction of the X-29A aircraft [NASA-TM-101735] p 652 N91-23133
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 1: Steady [AD-A233482] p 631 N91-24113
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 2: User manual for VORSTAB-2 [AD-A233483] p 631 N91-24114
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 3: Unsteady [AD-A233569] p 631 N91-24115

ANTENNA ARRAYS
High gain airborne antenna for satellite communications p 643 A91-39776

ANTENNA RADIATION PATTERNS
High gain airborne antenna for satellite communications p 643 A91-39776

APPLICATIONS PROGRAMS (COMPUTERS)
Water-cooling technique of high temperature gas turbine blade [DE91-764238] p 681 N91-23506
A general multiblock Euler code for propulsion integration. Volume 1: Theory document [NASA-CR-187484-VOL-1] p 632 N91-24120
A general multiblock Euler code for propulsion integration. Volume 3: User guide for the Euler code [NASA-CR-187484-VOL-3] p 632 N91-24122
The 3-D Navier-Stokes analysis of crossing, glancing shocks/turbulent boundary layer interactions [NASA-TM-104469] p 633 N91-24130
Advanced computational models for analyzing high speed propulsive flowfields p 686 N91-24291
ALDAS user's manual [NASA-TM-102831] p 687 N91-24757

APPROACH
Microwave landing system modeling with application to air traffic control [NASA-TM-102832] p 636 N91-23099
Determination of decision-height windows for decelerating IMC approaches in helicopters p 667 N91-23124
Simulation evaluation of a speed-guidance law for Harrier approach transitions [NASA-TM-102853] p 668 N91-24209

APPROACH CONTROL
Differential GPS terminal area test results [AD-A232668] p 644 N91-23106

ARCHITECTURE (COMPUTERS)
A new architecture and expert system for aircraft design synthesis p 652 N91-23132

ARMED FORCES (UNITED STATES)
A test of the American Safety Flight Systems, Inc. prebreather/portable oxygen system [AD-A232723] p 636 N91-23100

ARROW WINGS
The effects on aerodynamic performance of designing supersonic wings for laminar flow control [AD-A233040] p 654 N91-24197

ARTIFICIAL INTELLIGENCE
The design and simulation of an intelligent flight control system p 665 A91-40133

ASSEMBLING
The introduction of off-line programming techniques for the robotic assembly of aircraft structures [SME PAPER MS90-276] p 611 A91-36898
CAPP imitative system of aircraft assembly --- Computer Aided Process Planning p 611 A91-37061

ASTRONAUTICS
The role of organizations in professional development p 690 A91-38367

ASYMPTOTIC METHODS
Asymptotic theory of bending-torsion flutter of high aspect ratio wing in the torsion controlled domain p 675 A91-37846

ATMOSPHERIC ATTENUATION
Radiation transmission in adverse weather p 675 A91-37880

ATMOSPHERIC EFFECTS
Environmental exposure effects on composite materials for commercial aircraft [NASA-CR-187478] p 672 N91-24358

ATMOSPHERIC ENTRY
Re-entry flight control of space plane using approximate perfect servo p 664 A91-37778

ATMOSPHERIC MOISTURE
The LWC parameter - Some experimental results --- liquid water content in atmosphere p 685 A91-38388

ATMOSPHERIC SOUNDING
Integration of weather sensing devices p 639 N91-24174

ATOMIZING
Fuel-rich, catalytic reaction experimental results [NASA-TM-104423] p 662 N91-24203

ATTACK AIRCRAFT
Flying qualities experience on the AMX aircraft p 650 N91-23112

ATTITUDE CONTROL
Simulation evaluation of a speed-guidance law for Harrier approach transitions [NASA-TM-102853] p 668 N91-24209

ATTITUDE STABILITY
Simulation evaluation of a speed-guidance law for Harrier approach transitions [NASA-TM-102853] p 668 N91-24209

AUTOMATIC CONTROL
On digital electronic control system of aircraft engine p 657 A91-38209
Evaluation of automation for inspection of aging aircraft p 613 N91-24088
National remote computational flight research facility [NASA-CR-179432] p 668 N91-24210

AUTOMATIC FLIGHT CONTROL
The design and simulation of an intelligent flight control system p 665 A91-40133
Along for the ride? --- computer-automated aviation overview p 656 A91-40550

AUTOMATIC PILOTS
Integration of four-dimensional guidance with total energy control system --- integrated autopilot/autothrottle control system design p 665 A91-39410

AUTOMATION
Automatic aircraft paint stripping [SME PAPER MS90-280] p 611 A91-36895

AUXILIARY POWER SOURCES
Small Engine Component Technology (SECT) [NASA-CR-175078] p 662 N91-24205

AVAILABILITY
The costs and benefits of aircraft availability [AD-A232660] p 613 N91-23076

AVIATION METEOROLOGY
Clutter rejection in Doppler weather radars used for airport wind shear detection p 685 A91-37104
Aeronautical meteorology - Safety and economics of commercial air transports p 685 A91-38323
The LWC parameter - Some experimental results --- liquid water content in atmosphere p 685 A91-38388
Wind shear training applications for 91/135 p 639 N91-24173

AVIONICS
Aircraft electrical system computer simulation p 657 A91-38037
Flight management systems --- Book p 666 A91-40517
Avionic laser multisensor program at Litton Aero Products p 637 N91-24144

AXIAL FLOW
Temporally and spatially resolved flow in a two-stage axial compressor. II - Computational assessment [ASME PAPER 90-GT-299] p 620 A91-39048

AXISYMMETRIC BODIES
A simplified aerothermal heating method for axisymmetric blunt bodies p 619 A91-38787

AXISYMMETRIC FLOW
Computational analysis of underexpanded jets in the hypersonic regime p 615 A91-37421

B

B-1 AIRCRAFT
Development of B-1 antenna measurement test bed p 668 A91-37881
B-1B high AOA testing in the evaluation of a stall inhibitor system p 651 N91-23126
BALANCING
Balancing of rotating machinery p 679 A91-40278
BEARINGLESS ROTORS
Soft hub for bearingless rotors [NASA-CR-177586] p 654 N91-24198
BEND TESTS
Identification strategies for crack shape determination in rotors p 679 A91-40234
BENDING MOMENTS
Asymptotic theory of bending-torsion flutter of high aspect ratio wing in the torsion controlled domain p 675 A91-37846
BERYLLIUM ISOTOPES
Surface activation of Concorde by Be-7 p 690 N91-24983
BIBLIOGRAPHIES
Aircraft wake vortices: An annotated bibliography (1923-1990) [AD-A233161] p 631 N91-24111
BIOGRAPHY
AGARD highlights 91/1, March 1991 [AGARD-HIGHLIGHTS-91/1] p 691 N91-24084
BIRD-AIRCRAFT COLLISIONS
The nonlinear dynamic response analysis of the front windshield of Y12 under 'bird-impact' loads p 648 A91-40158
BLADE TIPS
Research on aerodynamic control of blade tip clearance flow in air-cooled turbine [DE91-764223] p 660 N91-23182
BLADE-VORTEX INTERACTION
A study of the noise mechanisms of transonic blade-vortex interactions [NASA-CR-188199] p 627 N91-23084
BLASIUS FLOW
Visual study of boundary layer transition on rotating flat plate p 623 A91-39941
BLUFF BODIES
Vortex shedding and lock-on in bluff body wakes p 675 A91-38689
BLUNT BODIES
Entropy effects of hypersonic flow past blunt delta wings p 615 A91-37181
Numerical study of hypersonic dissociated air past blunt bodies p 616 A91-37835
A simplified aerothermal heating method for axisymmetric blunt bodies p 619 A91-38787
BODIES OF REVOLUTION
Asymmetric vortices on a slender body of revolution p 616 A91-37827
Synchronous iterative method for computation of vortex flows at high angles of attack p 624 A91-40126
BODY-WING AND TAIL CONFIGURATIONS
Numerical investigation of airfoil/jet/fuselage-undersurface flowfields in ground effect p 617 A91-38541
BODY-WING CONFIGURATIONS
Aerodynamic characteristics of slender wing-gap-body combinations p 615 A91-37777
Transonic Symposium: Theory, Application and Experiment, volume 2 [NASA-CP-3020-VOL-2] p 634 N91-24132
Reynolds number effects on the transonic aerodynamics of a slender wing-body configuration p 634 N91-24134
BOEING AIRCRAFT
Safety of aging aircraft - Boeing programs for the 1990's [AIAA PAPER 91-0909] p 612 A91-40563
BOEING 727 AIRCRAFT
Modification meets Chapter 3 standards --- re-engined Boeing 727 p 612 A91-40181
MLS mathematical model validation study using airborne MLS data from Atlantic City International Airport Boeing 727 elevation shadowing flight tests [DOT-FAA/CT-TN90/55] p 644 N91-24190
BONDING
Bonded/fusion repair of aircraft structures p 613 N91-24160
BOUNDARY LAYER CONTROL
Moving surface boundary-layer control as applied to two-dimensional airfoils p 615 A91-37768
Analysis and control of low-speed forced unsteady flow p 676 A91-38697
Boundary layer control by a local heating of the wall p 678 A91-39909
A study of three dimensional turbulent boundary layer separation and vortex flow control using the reduced Navier Stokes equations [NASA-TM-104407] p 628 N91-23089
Passive laminar flow control of crossflow vorticity [NASA-CASE-LAR-13563-1] p 679 N91-23410
The NASA Langley laminar-flow-control experiment on a swept, supercritical airfoil: Suction coefficient analysis [NASA-TM-4267] p 629 N91-24098
Laminar-flow flight experiments p 634 N91-24135
Laminar-flow wind tunnel experiments p 634 N91-24136
The 1989 high-speed civil transport studies [NASA-CR-4375] p 654 N91-24195
The effects on aerodynamic performance of designing supersonic wings for laminar flow control [AD-A233040] p 654 N91-24197
Evaluation of cloud detection instruments and performance of laminar-flow leading-edge test articles during NASA Leading-Edge Flight-Test Program [NASA-TP-2888] p 655 N91-24199
BOUNDARY LAYER EQUATIONS
Calculation of low Reynolds number flows at high angles of attack p 624 A91-40218
BOUNDARY LAYER FLOW
Boundary layer control by a local heating of the wall p 678 A91-39909
Experiments on swept-wing boundary layers p 622 A91-39932
Receptivity and stability of the boundary layer at a high turbulence level p 678 A91-39945
The effect of isolated roughness elements on transition in attachment-line flows p 678 A91-39959
Boundary layer tripping in supersonic flow p 623 A91-39960
An experimental study of an axisymmetric turbulent boundary layer disturbed by a periodic freestream p 626 N91-23078
Coolant side heat transfer with rotation. Task 3 report: Application of computational fluid dynamics [NASA-CR-182109] p 683 N91-24551
BOUNDARY LAYER SEPARATION
Unsteady wave structure near separation in a Mach 5 compression ramp interaction p 616 A91-37838
Unsteady separation on an impulsively set into motion Carafoli airfoil p 618 A91-38694
Quantitative analysis of flow visualizations in ONERA water tunnels p 677 A91-39694
A study of three dimensional turbulent boundary layer separation and vortex flow control using the reduced Navier Stokes equations [NASA-TM-104407] p 628 N91-23089
Some aspects of shock-wave boundary layer interaction relevant to intake flows p 628 N91-23161
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 1: Steady [AD-A233482] p 631 N91-24113
BOUNDARY LAYER STABILITY
Real gas effects on hypersonic boundary-layer stability p 614 A91-36453
A model for the experimental study of curvature effects on transition of the boundary layer on a swept wing - Preliminary results p 620 A91-39691
Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Ecole Nationale Superieure de l'Aeronautique et de l'Espace, Toulouse, France, Sept. 11-15, 1989 p 677 A91-39901
Transition research in low-disturbance high-speed wind tunnels p 621 A91-39919
Correlation of boundary layer stability analysis with flight transition data p 621 A91-39929
Cross-flow instability of 3-D boundary layers on a flat plate p 622 A91-39931
Instability features appearing on swept wing configurations p 622 A91-39937
Development and interaction of instabilities in the crossflow field p 622 A91-39938
The experimental investigation of stability and receptivity of a swept-wing flow p 623 A91-39944
Receptivity and stability of the boundary layer at a high turbulence level p 678 A91-39945
Theoretical study of Goertler vortices - Linear stability approach p 623 A91-39950
Variable Sweep Transition Flight Experiment (VSTFE): Unified Stability System (USS). Description and users' manual [NASA-CR-181918] p 634 N91-24139
BOUNDARY LAYER TRANSITION
A model for the experimental study of curvature effects on transition of the boundary layer on a swept wing - Preliminary results p 620 A91-39691
Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Ecole Nationale Superieure de l'Aeronautique et de l'Espace, Toulouse, France, Sept. 11-15, 1989 p 677 A91-39901
Dialogue on progress and issues in stability and transition research p 677 A91-39902
Transition research in low-disturbance high-speed wind tunnels p 621 A91-39919
Experimental and theoretical analysis of natural transition on 'infinite' swept wing p 621 A91-39927
An evaluation of stability-based methods for transition of three-dimensional flows p 678 A91-39928
Correlation of boundary layer stability analysis with flight transition data p 621 A91-39929
On the stability of swept wing laminar boundary layers including curvature effects p 622 A91-39933
Development and interaction of instabilities in the crossflow field p 622 A91-39938
Visual study of boundary layer transition on rotating flat plate p 623 A91-39941
Receptivity and stability of the boundary layer at a high turbulence level p 678 A91-39945
Visualisation of boundary layer transition p 623 A91-39964
Airfoil transition and separation studies using an infrared imaging system p 624 A91-40215
Laminar-flow flight experiments p 634 N91-24135
Variable Sweep Transition Flight Experiment (VSTFE): Unified Stability System (USS). Description and users' manual [NASA-CR-181918] p 634 N91-24139
Effects of wing sweep on in-flight boundary-layer transition for a laminar flow wing at Mach numbers from 0.60 to 0.79 [NASA-TM-101701] p 683 N91-24555
Effects of wing sweep on boundary-layer transition for a smooth F-14A wing at Mach numbers from 0.700 to 0.825 [NASA-TM-101712] p 683 N91-24556
BRAYTON CYCLE
Water-cooling technique of high temperature gas turbine blade [DE91-764238] p 681 N91-23506
BRIGHTNESS
Radioluminescent (RL) lighting system development program [DE91-009743] p 679 N91-23381
BRUNT-VAISALA FREQUENCY
RADAR performance experiments p 639 N91-24168
BRUSHES
Simulation of brush insert for leading-edge-passage convective heat transfer [NASA-TM-103801] p 679 N91-23409
BUBBLES
A computationally efficient modelling of laminar separation bubbles p 680 N91-23411
BUFFETING
Buffet induced structural/flight-control system interaction of the X-29A aircraft [NASA-TM-101735] p 652 N91-23133
Flow visualization study of a 1/48-scale AFTI/F111 model to investigate horizontal tail flow disturbances [NASA-TM-101698] p 633 N91-24128
BURNING RATE
Kinetic study of a homogeneous propellant primary flame, with and without additive p 671 A91-39690

C

CALIBRATING
ALDAS user's manual [NASA-TM-102831] p 687 N91-24757
CANARD CONFIGURATIONS
Tip vortex/airfoil interaction for a low Reynolds number canard/wing configuration p 617 A91-38545
Effects of canard position on the aerodynamic characteristics of a close-coupled canard configuration at low speed p 649 A91-40495
Computational support of the X-29A Advanced Technology Demonstrator flight experiment p 653 N91-24137
CANOPIES
Canopy breaking system for non-delay pilot rescue p 647 A91-39398
CARBON DIOXIDE LASERS
Continuous wave laser for wind shear detection p 637 N91-24142
CARGO
Low Altitude High Speed Cargo Parachute system development - A status report [AIAA PAPER 91-0880] p 635 A91-40558
CARGO AIRCRAFT
Fire detection system for aircraft cargo bays p 655 A91-36755
CASCADE FLOW
Unsteady pressure fluctuation on a highly loaded turbine blade row p 619 A91-38702

Computation of three-dimensional flow fields through compressor blade rows p 625 A91-40375
Euler calculations of unsteady transonic flow in cascades
[AIAA PAPER 91-1104] p 626 A91-40562
Aero-thermal investigation of a highly loaded transonic linear turbine guide vane cascade. A test case for inviscid and viscous flow computations
[VKI-TN-174] p 680 N91-23437
Viscous design and analysis methods for transonic compressor blading
[AD-A232902] p 682 N91-24530

CATALYSTS
Fuel-rich, catalytic reaction experimental results
[NASA-TM-104423] p 662 N91-24203

CAVITIES
Steady flow in a three-dimensional rectangular cavity yawed from the freestream turbulent boundary layer p 619 A91-38742

CENTRIFUGAL PUMPS
Fluid Machinery Forum - 1990; ASME Spring Meeting, University of Toronto, Canada, June 4-7, 1990, Proceedings p 676 A91-38869
Toward automating the design of centrifugal impellers p 676 A91-38874

CERAMIC MATRIX COMPOSITES
Oxidation resistant carbon/carbon materials
[REPT-911-430-105] p 672 N91-23251
How to know CMC
[REPT-911-430-130] p 672 N91-23262

CERAMICS
Fabrication of engineering ceramics by injection molding p 674 A91-37375
Improved silicon carbide for advanced heat engines
[NASA-CR-182289] p 672 N91-24451

CERTIFICATION
The certification of the aircraft integrated propulsive system
[REPT-911-111-102] p 661 N91-23188
Kansas Aviation Review
[NIAR-91-3] p 613 N91-24087
Analytical certification of aircraft structures p 684 N91-24641
Beechcraft starship strength certification p 684 N91-24643
The role of structural analysis in airworthiness certification p 684 N91-24647
Probability approach for strength calculations p 685 N91-24652
AGARD flight test techniques series. Volume 9: Aircraft exterior noise measurement and analysis techniques
[AGARD-AG-300-VOL-9] p 689 N91-24843

CHANNEL FLOW
Mixing of multiple jets with a confined subsonic crossflow. Summary of NASA-supported experiments and modeling
[NASA-TM-104412] p 662 N91-24202

CIRCULAR CYLINDERS
Rotary oscillation control of a cylinder wake p 620 A91-39708
Secondary frequencies in the wake of a circular cylinder with vortex shedding p 620 A91-39736

CIRCULATION
Simulation of the flow past an impulsively started cylinder using a discrete vortex method
[AD-A233066] p 683 N91-24533

CIRCULATION CONTROL AIRFOILS
Aerodynamic calculation of tandem wings in supersonic flow by means of SLLT p 614 A91-36724
Dynamic stall of an oscillating circulation control airfoil p 617 A91-38677

CIVIL AVIATION
The English summer of 1990 - Further progress towards deregulation of the aviation and travel industry p 690 A91-37801
Air travel - System relating flight safety, aircraft, and airports p 634 A91-38527
Aeronautical research in the United States - Challenges for the 1990's p 612 A91-38580
Euler analysis of a High-Speed Civil Transport concept at Mach 3 p 624 A91-40217
Engine technology challenges for a 21st century high speed civil transport
[NASA-TM-104363] p 636 N91-23098
Do civil flying qualities requirements address military missions for off-the-shelf procurement p 650 N91-23115
An investigation into the use of side-arm control for civil rotorcraft applications p 667 N91-23123
Integration of propulsive systems: Selection and compromise
[REPT-911-111-101] p 661 N91-23187
Observatory of new materials. Evolution perspectives for the materials used in civil transportation aircraft
[REPT-911-111-107] p 672 N91-23248
The 1989 high-speed civil transport studies
[NASA-CR-4375] p 654 N91-24195
AGARD flight test techniques series. Volume 9: Aircraft exterior noise measurement and analysis techniques
[AGARD-AG-300-VOL-9] p 689 N91-24843

CLEARANCES
Research on aerodynamic control of blade tip clearance flow in air-cooled turbine
[DE91-764223] p 660 N91-23182

CLIMBING FLIGHT
Aircraft performance p 649 A91-40511

CLIPS
Airborne rescue system
[NASA-CASE-ARC-11909-1] p 635 N91-23095

CLOUD COVER
RADAR performance experiments p 639 N91-24168

CLOUDS
Evaluation of cloud detection instruments and performance of laminar-flow leading-edge test articles during NASA Leading-Edge Flight-Test Program
[NASA-TP-2888] p 655 N91-24199

CLUTTER
Evolution of clutter suppression techniques for air traffic control and surveillance radar p 641 A91-37101
Saberliner flight test for airborne wind shear forward looking detection and avoidance radar systems p 637 N91-24149
Clutter modeling of the Denver Airport and surrounding areas p 638 N91-24152
Radar simulation program upgrade and algorithm development p 638 N91-24153
Signal processing techniques for clutter filtering and wind shear detection p 638 N91-24154
Description, characteristics and testing of the NASA airborne radar p 638 N91-24156

COCKPITS
Kansas Aviation Review
[NIAR-91-3] p 613 N91-24087

COHERENT RADAR
Radar simulation program upgrade and algorithm development p 638 N91-24153
Description, characteristics and testing of the NASA airborne radar p 638 N91-24156

COLLISION AVOIDANCE
Air traffic control today and tomorrow p 642 A91-38215
Airborne Collision Avoidance System (ACAS) in controlled air traffic. Aspects of reciprocal influence in Secondary Surveillance Radar (SSR) radio loads
[ETN-91-99253] p 644 N91-23105

COMBAT
Toward enhanced fighter combat effectiveness p 645 A91-37050
One-on-one helicopter combat simulated by chess-type lookahead p 668 A91-37775

COMBUSTIBLE FLOW
Subsonic and supersonic combustion using noncircular injectors p 674 A91-37414

COMBUSTION
Aerodynamics and stabilization of combustion of hydrogen jets injected into subsonic airflow p 629 N91-23164
Fuel-rich, catalytic reaction experimental results
[NASA-TM-104423] p 662 N91-24203

COMBUSTION CHAMBERS
Design and development of aviation gas turbine engines --- Russian book p 657 A91-39201
Design techniques for dual mode ram-scramjet combustors p 659 N91-23166
Analytical and experimental investigations of the oblique detonation wave engine concept p 660 N91-23169
A CFD study of jet mixing in reduced flow areas for lower combustor emissions
[NASA-TM-104411] p 661 N91-23185
The effects of controlling vortex formation on the performance of a dump combustor p 672 N91-23270
Mixing of multiple jets with a confined subsonic crossflow. Summary of NASA-supported experiments and modeling
[NASA-TM-104412] p 662 N91-24202
An experimental evaluation of combustor liner materials for solid fuel ramjet testing p 670 N91-24289

COMBUSTION EFFICIENCY
A CFD study of jet mixing in reduced flow areas for lower combustor emissions
[NASA-TM-104411] p 661 N91-23185
Fuel-rich, catalytic reaction experimental results
[NASA-TM-104423] p 662 N91-24203
An experimental evaluation of combustor liner materials for solid fuel ramjet testing p 670 N91-24289

COMBUSTION PHYSICS
Kinetic study of a homogeneous propellant primary flame, with and without additive p 671 A91-39690

COMBUSTION STABILITY
The effects of controlling vortex formation on the performance of a dump combustor p 672 N91-23270

COMMERCIAL AIRCRAFT
Long-range aircraft are in demand p 611 A91-36353
Practical considerations in optimal and 4-dimensional flight management computations p 686 A91-37585
Commercial aircraft fuel efficiency potential through 2010 p 645 A91-38127
Tiltrotor developments p 612 A91-40180
Engine technology challenges for a 21st century high speed civil transport
[NASA-TM-104363] p 636 N91-23098

COMMUNICATION NETWORKS
National airspace system. Communications operational concept NAS-SR-136
[DOT/FAA/SE-91/1] p 640 N91-24185

COMPONENT RELIABILITY
Probability approach for strength calculations p 685 N91-24652

COMPOSITE MATERIALS
Designing with composites - A study of design process p 646 A91-38752
Composites for a widebody p 612 A91-39852
Moulded Mustang p 612 A91-39854
Design and construction of a composite airframe for UAV research
[AD-A232422] p 653 N91-23143
Integration of propulsive systems: Selection and compromise
[REPT-911-111-101] p 661 N91-23187
Observatory of new materials. Evolution perspectives for the materials used in civil transportation aircraft
[REPT-911-111-107] p 672 N91-23248
The role of analysis in the design and qualification of composite aircraft structures p 684 N91-24648

COMPOSITE STRUCTURES
Spot welded thermoplastic composite access door
[SME PAPER EM90-489] p 645 A91-36942
Analytical studies on static aeroelastic behavior of forward-swept composite wing structures p 674 A91-37774
Designing with composites - A study of design process p 646 A91-38752
Flexural waves induced by electro-impulse deicing forces p 676 A91-38776
A new technique and application for nonlinear acoustic fatigue of stiffened composite panels p 687 A91-38863
Design and construction of a composite airframe for UAV research
[AD-A232422] p 653 N91-23143
Bonded/fusion repair of aircraft structures p 613 N91-24160
Mechanical paint removal techniques for composite aircraft p 613 N91-24163
Soft hub for bearingless rotors
[NASA-CR-177586] p 654 N91-24198
The role of analysis in the design and qualification of composite aircraft structures p 684 N91-24648

COMPRESSED GAS
An isentropic compression-heated Ludweig tube transient wind tunnel p 673 A91-36450

COMPRESSIBILITY EFFECTS
An efficient hybrid scheme for the solution of rotational flow around advanced propellers p 629 N91-24104

COMPRESSIBLE BOUNDARY LAYER
On the instability of hypersonic flow past a wedge p 621 A91-39922

COMPRESSIBLE FLOW
Structure of the compressible turbulent shear layer p 616 A91-37830
Block multigrid implicit solution of the Euler equations of compressible fluid flow p 616 A91-37836
Unsteady wave structure near separation in a Mach 5 compression ramp interaction p 616 A91-37838
Theoretical study of Goertler vortices - Linear stability approach p 623 A91-39950
Second mode interactions in supersonic boundary layers p 623 A91-39957
Procedure for determination of three-dimensional wind tunnel wall interferences and wall adaptation in compressible subsonic flow using measured wall pressures
[DLR-FB-90-46] p 628 N91-23088
Block implicit multigrid solution of the Euler equations p 680 N91-23413
Euler flow predictions for an oscillating cascade using a high resolution wave-split scheme
[NASA-TM-104377] p 630 N91-24107

COMPRESSOR BLADES
Residual stress control in developing processes for the manufacture of compressor blades for gas turbine engines p 674 A91-37269

Experimental investigation of loading effects on compressor trailing-edge flowfields p 615 A91-37420
Computation of three-dimensional flow fields through compressor blade rows p 625 A91-40375
A new facility to study three dimensional viscous flow and rotor-stator interaction in turbines p 682 N91-24336
Viscous design and analysis methods for transonic compressor blading [AD-A232902] p 682 N91-24530

COMPRESSOR ROTORS
Effects of inlet distortion on the development of secondary flows in a subsonic axial inlet compressor rotor [NASA-TM-104356] p 660 N91-23179
A new facility to study three dimensional viscous flow and rotor-stator interaction in turbines p 682 N91-24336

COMPUTATIONAL FLUID DYNAMICS
Aerodynamic calculation of tandem wings in supersonic flow by means of SLLT p 614 A91-36724
A comparison between computation and experiment for flows around airfoil with slat and flap p 616 A91-37780
Interactive three-dimensional boundary-layer method for transonic flow over swept wings p 616 A91-37829
Numerical study of hypersonic dissociated air past blunt bodies p 616 A91-37835
Block multigrid implicit solution of the Euler equations of compressible fluid flow p 616 A91-37836
Three-dimensional composite velocity solutions for subsonic/transonic flow p 616 A91-37841
Airfoil design method using the Navier-Stokes equations p 646 A91-38550
Application of vortex dynamics to simulations of two-dimensional wakes p 676 A91-38706
Temporally and spatially resolved flow in a two-stage axial compressor. II - Computational assessment [ASME PAPER 90-GT-299] p 620 A91-39048
Secondary frequencies in the wake of a circular cylinder with vortex shedding p 620 A91-39736
Direct numerical study of crossflow instability p 678 A91-39956
Second mode interactions in supersonic boundary layers p 623 A91-39957
Euler analysis of a High-Speed Civil Transport concept at Mach 3 p 624 A91-40217
Low-order panel method for internal flows p 625 A91-40225
A new pseudo-potential function model for rotational flow and its application to transonic-supersonic flow p 625 A91-40373
Computation of three-dimensional flow fields through compressor blade rows p 625 A91-40375
Analysis of numerical solutions for three-dimensional lifting wing flows p 625 A91-40498
Fluid dynamics for the study of transonic flow --- Book p 625 A91-40513
Euler calculations of unsteady transonic flow in cascades [AIAA PAPER 91-1104] p 626 A91-40562
Hypersonic Combined Cycle Propulsion [AGARD-CP-479] p 657 N91-23147
Hypersonic propulsion: Status and challenge p 658 N91-23153
Analytical and experimental investigations of the oblique detonation wave engine concept p 660 N91-23169
Viscous three-dimensional analyses for nozzles for hypersonic propulsion p 629 N91-23175
Computation of inlet reference plane flow-field for a subscale free-jet forebody/inlet model and comparison to experimental data [AD-A232101] p 680 N91-23445
Transonic Symposium: Theory, Application and Experiment, volume 2 [NASA-CP-3020-VOL-2] p 634 N91-24132
Advanced Hypervelocity Aerophysics Facility Workshop [NASA-CP-10031] p 669 N91-24211
Advanced computational models for analyzing high speed propulsive flowfields p 686 N91-24291
Coolant side heat transfer with rotation. Task 3 report: Application of computational fluid dynamics [NASA-CR-182109] p 683 N91-24551
Enhancing aeropropulsion research with high-speed interactive computing [NASA-TM-104374] p 687 N91-24796

COMPUTATIONAL GRIDS
Cell centered and cell vertex multigrid schemes for the Navier-Stokes equations p 674 A91-37834
Transonic analysis and design using an improved grid p 624 A91-40137
Reacting shock waves in hypersonic propulsion applications p 629 N91-23174
Block implicit multigrid solution of the Euler equations p 680 N91-23413
Implicit solvers for unstructured meshes [NASA-CR-187564] p 633 N91-24125

COMPUTER AIDED DESIGN
The introduction of off-line programming techniques for the robotic assembly of aircraft structures [SME PAPER MS90-276] p 611 A91-36898
Automated CAD design for sculptured airfoil surfaces [SME PAPER MS90-744] p 673 A91-36943
CAPP imitative system of aircraft assembly --- Computer Aided Process Planning p 611 A91-37061
The development and research on CAD for education on aircraft design p 686 A91-38234
Aircraft design for maintainability p 612 A91-38546
A computer aided multivariable control systems design technique with application to aircraft flying qualities [AD-A232549] p 653 N91-23144
Integration of propulsive systems: Selection and compromise [REPT-911-111-101] p 661 N91-23187
A general multiblock Euler code for propulsion integration. Volume 1: Theory document [NASA-CR-187484-VOL-1] p 632 N91-24120
A general multiblock Euler code for propulsion integration. Volume 2: User guide for BCON, pre-processor for grid generation and GMBE [NASA-CR-187484-VOL-2] p 632 N91-24121
A general multiblock Euler code for propulsion integration. Volume 3: User guide for the Euler code [NASA-CR-187484-VOL-3] p 632 N91-24122
A system approach to aircraft optimization [NASA-TM-104074] p 654 N91-24196
The role of structural analysis in airworthiness certification p 684 N91-24647

COMPUTER AIDED MANUFACTURING
CAPP imitative system of aircraft assembly --- Computer Aided Process Planning p 611 A91-37061
A system approach to aircraft optimization [NASA-TM-104074] p 654 N91-24196

COMPUTER DESIGN
Design and implementation of real-time computer coordinated force actuating system with multi-input/output [AD-A233114] p 687 N91-24768

COMPUTER GRAPHICS
A dynamic analysis of the SRB parachute system [AIAA PAPER 91-0838] p 670 A91-40555
A general multiblock Euler code for propulsion integration. Volume 2: User guide for BCON, pre-processor for grid generation and GMBE [NASA-CR-187484-VOL-2] p 632 N91-24121

COMPUTER PROGRAMS
Development and demonstration of CREST subsystems --- computer program for ejection seats p 646 A91-39380
Application of multiple-input/single-output analysis procedures to flight test data p 647 A91-39420
Aerodynamic preliminary analysis system 2. Part 1: Theory [NASA-CR-182076] p 626 N91-23080
Theoretical and experimental performance of a solid fuel ramjet combustion cycle for hypersonic flight conditions p 660 N91-23170
Viscous three-dimensional analyses for nozzles for hypersonic propulsion p 629 N91-23175
Computation of inlet reference plane flow-field for a subscale free-jet forebody/inlet model and comparison to experimental data [AD-A232101] p 680 N91-23445
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 3: Application of theory for blade loading, wakes, noise, and wing shielding [NASA-CR-185193] p 688 N91-23850
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 5: Propagation of propeller tone noise through a fuselage boundary layer [NASA-CR-185195] p 689 N91-23852
An initial investigation into methods of computing transonic aerodynamic sensitivity coefficients [NASA-CR-188192] p 629 N91-24099
Euler flow predictions for an oscillating cascade using a high resolution wave-split scheme [NASA-TM-104377] p 630 N91-24107
Developing and utilizing an Euler computational method for predicting the airframe/propulsion effects for an aft-mounted turboprop transport. Volume 2: User guide [NASA-CR-181924-VOL-2] p 632 N91-24119
A general multiblock Euler code for propulsion integration. Volume 2: User guide for BCON, pre-processor for grid generation and GMBE [NASA-CR-187484-VOL-2] p 632 N91-24121
The effects on aerodynamic performance of designing supersonic wings for laminar flow control [AD-A233040] p 654 N91-24197
Application of cyclic damage accumulation life prediction model to high temperature components p 681 N91-24309
Coolant side heat transfer with rotation. Task 3 report: Application of computational fluid dynamics [NASA-CR-182109] p 683 N91-24551
Simulation of a combined-cycle engine [NASA-CR-188232] p 683 N91-24583
Signal processing of aircraft flyover noise [NASA-CR-187546] p 690 N91-24845

COMPUTER SYSTEMS DESIGN
NASA-LaRc Flight-Critical Digital Systems Technology Workshop [NASA-CP-10028] p 655 N91-24200

COMPUTER SYSTEMS PERFORMANCE
Enhancing aeropropulsion research with high-speed interactive computing [NASA-TM-104374] p 687 N91-24796

COMPUTER SYSTEMS PROGRAMS
Enhancing aeropropulsion research with high-speed interactive computing [NASA-TM-104374] p 687 N91-24796

COMPUTER TECHNIQUES
Influence of the refinement of structural calculation on aircraft qualification procedures p 684 N91-24649

COMPUTERIZED SIMULATION
Temporally and spatially resolved flow in a two-stage axial compressor. II - Computational assessment [ASME PAPER 90-GT-299] p 620 A91-39048
Simulation of G(x) forces using horizontal impulse accelerators p 668 A91-39396
Angle-only tracking filter in modified spherical coordinates p 643 A91-39433
Lateral-direction tracking requirements from simulation data p 686 A91-39436
Further experiments on vortex formation around an oscillating and translating airfoil at large incidences p 620 A91-39738
Model for IR sensor performance evaluation - Applications and results p 656 A91-39890
Synchronous iterative method for computation of vortex flows at high angles of attack p 624 A91-40126
Icing simulation: A survey of computer models and experimental facilities [NASA-TM-104366] p 628 N91-23087
A CFD study of jet mixing in reduced flow areas for lower combustor emissions [NASA-TM-104411] p 661 N91-23185
Computerized system for static and fatigue large scale structural tests: A case study [IAITIC-87-1007] p 681 N91-23522
An initial investigation into methods of computing transonic aerodynamic sensitivity coefficients [NASA-CR-188192] p 629 N91-24099
LIDAR studies on microbursts p 639 N91-24167
Average-passage flow model development p 682 N91-24338
Simulation of a combined-cycle engine [NASA-CR-188232] p 683 N91-24583
Validation of in-house and external software systems at Aerospatiale p 687 N91-24640
Evaluation of the qualification of the structure of a passenger aircraft by analysis and full-scale testing p 684 N91-24645
Enhancing aeropropulsion research with high-speed interactive computing [NASA-TM-104374] p 687 N91-24796

COMPUTERS
National remote computational flight research facility [NASA-CR-179432] p 668 N91-24210

CONCORDE AIRCRAFT
Surface activation of Concorde by Be-7 p 690 N91-24983

CONFERENCES
Fluid Machinery Forum - 1990; ASME Spring Meeting, University of Toronto, Canada, June 4-7, 1990, Proceedings p 676 A91-38869
Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Ecole Nationale Superieure de l'Aeronautique et de l'Espace, Toulouse, France, Sept. 11-15, 1989 p 677 A91-39901
Flying Qualities [AGARD-CP-508] p 649 N91-23108
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 2 [NASA-CP-10060-PT-2] p 636 N91-24140
Analytical Qualification of Aircraft Structures [AGARD-R-772] p 683 N91-24638

CONICAL FLOW
Inception length to a fully developed, fin-generated, shock-wave, boundary-layer interaction p 617 A91-37842

CONSTRAINTS
The limits of the landing process of aircraft [DLR-FB-90-49] p 653 N91-23137

CONSTRUCTION
Design and construction of a composite airframe for UAV research
[AD-A232422] p 653 N91-23143
CONSTRUCTION MATERIALS
Literature review on geotextiles to improve pavements for general aviation airports
[AD-A232871] p 669 N91-23199
CONTAMINATION
An experimental investigation of vortex pair interaction with a clean or contaminated free surface
p 680 N91-23419
CONTINUOUS WAVE LASERS
Continuous wave laser for wind shear detection
p 637 N91-24142
CONTRAROTATING PROPELLERS
An efficient hybrid scheme for the solution of rotational flow around advanced propellers p 629 N91-24104
CONTROL CONFIGURED VEHICLES
Decoupled flight control via a model-following technique using the Euler operator p 664 A91-37595
CONTROL STABILITY
Control law synthesis and stability robustness improvement using constrained optimization techniques
p 686 A91-37591
CONTROL STICKS
An initial study into the influence of control stick characteristics on the handling qualities of a fly-by-wire helicopter p 651 N91-23122
CONTROL SURFACES
Research on aerodynamic control of blade tip clearance flow in air-cooled turbine
[DE91-764223] p 660 N91-23182
CONTROL SYSTEMS DESIGN
Decoupled flight control via a model-following technique using the Euler operator p 664 A91-37595
On digital electronic control system of aircraft engine
p 657 A91-38209
Evolution of airplane stability and control - A designer's viewpoint p 665 A91-39401
Integration of four-dimensional guidance with total energy control system --- integrated autopilot/autothrottle control system design p 665 A91-39410
Robust eigenstructure assignment with structured state space uncertainty p 686 A91-39417
Hot gas ingestion test results of a two-poster vectored thrust concept with flow visualization in the NASA Lewis 9- by 15-foot low speed wind tunnel
[AIAA PAPER 90-2268] p 626 A91-40561
Unsteady flow structure from swept edges subjected to controlled motion
[AD-A232714] p 628 N91-23094
B-1B high AOA testing in the evaluation of a stall inhibitor system p 651 N91-23126
Flying qualities of the X-29 forward swept wing aircraft
p 651 N91-23127
A computer aided multivariable control systems design technique with application to aircraft flying qualities
[AD-A232549] p 653 N91-23144
Integrated multidisciplinary optimization of actively controlled fiber composite wings p 667 N91-23190
The effects of controlling vortex formation on the performance of a dump combustor p 672 N91-23270
Design and implementation of real-time computer coordinated force actuating system with multi-input/output
[AD-A233114] p 687 N91-24768
CONTROL THEORY
Control law synthesis and stability robustness improvement using constrained optimization techniques
p 686 A91-37591
Improvement of atmospheric flight performance of a space vehicle through sensitivity minimization
p 664 A91-37779
CONTROLLABILITY
The influence of altitude and speed variations over the aircraft flight control response during the longitudinal nonlinear manoeuvres p 664 A91-36722
Handling qualities of highly augmented unstable aircraft summary of an AGARD-FMP working group effort
p 666 N91-23116
The handling qualities of the STOL and maneuver technology demonstrator from specification to flight test
p 666 N91-23117
Metrics for roll response flying qualities
p 650 N91-23118
Handling qualities guidelines for the design of fly-by-wire flight control systems for transport aircraft
p 667 N91-23119
An initial study into the influence of control stick characteristics on the handling qualities of a fly-by-wire helicopter p 651 N91-23122
An investigation into the use of side-arm control for civil rotorcraft applications p 667 N91-23123
Determination of decision-height windows for decelerating IMC approaches in helicopters
p 667 N91-23124
Integration of handling quality aspects into the aerodynamic design of modern unstable fighters
p 667 N91-23125
Handling qualities evaluation for highly augmented helicopters p 651 N91-23128
A review of high angle of attack requirements for combat aircraft p 651 N91-23130
X-31A at first flight p 651 N91-23131
Evaluation techniques for highly augmented aircraft
[DLR-FB-90-35] p 667 N91-23191
Soft hub for bearingless rotors
[NASA-CR-177586] p 654 N91-24198
CONTROLLERS
An initial study into the influence of control stick characteristics on the handling qualities of a fly-by-wire helicopter p 651 N91-23122
Design and implementation of real-time computer coordinated force actuating system with multi-input/output
[AD-A233114] p 687 N91-24768
CONVECTIVE HEAT TRANSFER
Simulation of brush insert for leading-edge-passage convective heat transfer
[NASA-TM-103801] p 679 N91-23409
Aero-thermal investigation of a highly loaded transonic linear turbine guide vane cascade. A test case for inviscid and viscous flow computations
[VKI-TN-174] p 680 N91-23437
CONVERGENCE
Implicit solvers for unstructured meshes
[NASA-CR-187564] p 633 N91-24125
COOLING SYSTEMS
Research on aerodynamic control of blade tip clearance flow in air-cooled turbine
[DE91-764223] p 660 N91-23182
Coolant side heat transfer with rotation. Task 3 report: Application of computational fluid dynamics
[NASA-CR-182109] p 683 N91-24551
CORIOLIS EFFECT
Visual study of boundary layer transition on rotating flat plate p 623 A91-39941
CORROSION RESISTANCE
Composites for a widebody p 612 A91-39852
COST EFFECTIVENESS
The costs and benefits of aircraft availability
[AD-A232660] p 613 N91-23076
Simulation evaluation of a speed-guidance law for Harrier approach transitions
[NASA-TM-102853] p 668 N91-24209
COST ESTIMATES
Estimating fixed and variable costs of airframe manufacturers
[AD-A232661] p 613 N91-23077
Small Engine Component Technology (SECT) study. Program report
[NASA-CR-175077] p 662 N91-24204
COUNTER ROTATION
An efficient hybrid scheme for the solution of rotational flow around advanced propellers p 629 N91-24104
COUPLES
Modal analysis of multistage gear systems coupled with gearbox vibrations
[NASA-TM-103797] p 681 N91-23513
CRACK GEOMETRY
Identification strategies for crack shape determination in rotors p 679 A91-40234
CRACK INITIATION
Feasibility study in crack detection in aircraft stiffened panels by pulse probing and deconvolution
p 654 N91-24158
Application of cyclic damage accumulation life prediction model to high temperature components
p 681 N91-24309
CRACK PROPAGATION
Modeling of creep-fatigue interaction effects on crack growth p 670 A91-38802
Fatigue crack growth in monolithic titanium aluminides
p 670 A91-38809
Fatigue crack growth modeling at elevated temperature using fracture mechanics p 671 A91-38812
Application of path-independent integrals to elevated temperature crack growth p 671 A91-38819
CRACKS
Feasibility study in crack detection in aircraft stiffened panels by pulse probing and deconvolution
p 654 N91-24158
CRASHES
The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the copilot/gunner, volume 2
[AD-A232907] p 641 N91-24187
CRASHWORTHINESS
Program plans for aviation safety research
[NIAR-90-32] p 638 N91-24157
Crashworthiness experiments p 638 N91-24161
CREEP TESTS
Modeling of creep-fatigue interaction effects on crack growth p 670 A91-38802
CREWS
A test of the American Safety Flight Systems, Inc. prebreather/portable oxygen system
[AD-A232723] p 636 N91-23100
CRITERIA
Evaluation of automation for inspection of aging aircraft p 613 N91-24088
CROSS FLOW
Experimental and theoretical analysis of natural transition on 'infinite' swept wing p 621 A91-39927
Cross-flow instability of 3-D boundary layers on a flat plate p 622 A91-39931
Experiments on swept-wing boundary layers
p 622 A91-39932
Development and interaction of instabilities in the crossflow field p 622 A91-39938
Direct numerical study of crossflow instability
p 678 A91-39956
Experiments on the unsteadiness associated with a ground vortex p 624 A91-40220
Passive laminar flow control of crossflow vorticity
[NASA-CASE-LAR-13563-1] p 679 N91-23410
Mixing of multiple jets with a confined subsonic crossflow. Summary of NASA-supported experiments and modeling
[NASA-TM-104412] p 662 N91-24202
CRUISE MISSILES
Small Engine Component Technology (SECT) studies
[NASA-CR-175080] p 663 N91-24206
CRUISING FLIGHT
Long-range aircraft are in demand
p 611 A91-36353
Euler analysis of a High-Speed Civil Transport concept at Mach 3 p 624 A91-40217
CRYOGENICS
Development of a quiet supersonic wind tunnel with a cryogenic adaptive nozzle
[NASA-CR-186769] p 669 N91-23195
National Transonic Facility status p 669 N91-24133
CUES
The flying qualities influence of delay in the fighter pilot's cuing environment p 650 N91-23120
CYCLES
Simulation of a combined-cycle engine
[NASA-CR-188232] p 683 N91-24583
CYCLIC LOADS
Modeling of creep-fatigue interaction effects on crack growth p 670 A91-38802
Fatigue crack growth modeling at elevated temperature using fracture mechanics p 671 A91-38812
Analytical methods for the qualification of helicopter structures p 684 N91-24650
CYLINDRICAL SHELLS
Flexural waves induced by electro-impulse deicing forces p 676 A91-38776

D

DAMAGE
Program plans for aviation safety research
[NIAR-90-32] p 638 N91-24157
DAMAGE ASSESSMENT
Application of cyclic damage accumulation life prediction model to high temperature components
p 681 N91-24309
DATA ACQUISITION
National Transonic Facility status p 669 N91-24133
ALDAS user's manual
[NASA-TM-102831] p 687 N91-24757
AGARD flight test techniques series. Volume 9: Aircraft exterior noise measurement and analysis techniques
[AGARD-AG-300-VOL-9] p 689 N91-24843
DATA BASES
Differential GPS terminal area test results
[AD-A232668] p 644 N91-23106
An overview of information resources in aviation
p 690 N91-24091
Suckdown, fountain lift, and pressures induced on several tandem jet V/STOL configurations
[NASA-TM-102817] p 630 N91-24108
DATA LINKS
Flight tests show potential benefits of data link as primary communication medium p 643 A91-38577
DATA PROCESSING
Functional-adaptive data processing in airborne radio navigation and landing systems p 643 A91-39187

AGARD flight test techniques series. Volume 9: Aircraft exterior noise measurement and analysis techniques
[AGARD-AG-300-VOL-9] p 689 N91-24843
DATA PROCESSING EQUIPMENT
Evaluation of the performance of a RISC based real time data processor in air traffic control radar applications p 642 A91-37145
DATA RECORDERS
Recent escape system parachute efforts at Douglas Aircraft Company p 635 A91-39393
DATA TRANSMISSION
SATURN: The next generation radio for NATO p 682 N91-24475
DECELERATION
Simulation evaluation of a speed-guidance law for Harrier approach transitions
[NASA-TM-102853] p 668 N91-24209
DECISION MAKING
Some analysis of decision-making in the test manufacture of military aircraft
[AD-A233111] p 613 N91-24093
DEFORMATION
The computation of induced drag with nonplanar and deformed wakes p 630 N91-24106
DEGREES OF FREEDOM
Transonic flutter analysis of 2-D airfoils with 2 degrees of freedom p 665 A91-40169
Preference for an inertial degree of freedom describing the teeter motion of windturbine and helicopter rotors p 679 A91-40239
DEICERS
Advanced ice protection systems test in the NASA Lewis icing research tunnel
[NASA-TM-103757] p 661 N91-23183
DEICING
Flexural waves induced by electro-impulse deicing forces p 676 A91-38776
Icing simulation: A survey of computer models and experimental facilities
[NASA-TM-104366] p 628 N91-23087
Advanced ice protection systems test in the NASA Lewis icing research tunnel
[NASA-TM-103757] p 661 N91-23183
DELTA WINGS
Entropy effects of hypersonic flow past blunt delta wings p 615 A91-37181
Unsteady aerodynamic loading of delta wings for low and high angles of attack p 617 A91-38680
Visualization of the flow about a delta wing maneuvering in pitch to very high angle of attack p 618 A91-38684
Static measurements of slender delta wing rolling moment hysteresis p 625 A91-40223
The performance of 60 deg delta wings: The effects of leading edge radius on vortex flaps and the wing
[CRANFIELD-AERO-9004] p 628 N91-23092
Unsteady flow structure from swept edges subjected to controlled motion
[AD-A232714] p 628 N91-23094
The performance of 60 deg delta wings: The effects of leading edge radius and vortex flaps
[CRANFIELD-AERO-9002] p 653 N91-23140
An experimental investigation of vortex pair interaction with a clean or contaminated free surface p 680 N91-23419
Breaking down the delta wing vortex: The role of vorticity in the breakdown process
[NASA-CR-188235] p 630 N91-24109
An experimental analysis of critical factors involved in the breakdown process of leading edge vortex flows
[NASA-CR-188231] p 631 N91-24110
DEPLOYMENT
Deployment optimization and human factors considerations for low-attitude troop parachutes
[AIAA PAPER 91-0889] p 635 A91-40559
DESIGN ANALYSIS
Airfoil design method using the Navier-Stokes equations p 646 A91-38550
Designing with composites - A study of design process p 646 A91-38752
Aerodynamic preliminary analysis system 2. Part 2: User's manual
[NASA-CR-182077] p 627 N91-23081
MIL-STD-1797 is not a cookbook p 650 N91-23111
A new architecture and expert system for aircraft design synthesis p 652 N91-23132
Application of multidisciplinary optimization methods to the design of a supersonic transport
[NASA-TM-104073] p 652 N91-23135
Design techniques for dual mode ram-scramjet combustors p 659 N91-23166
Performance characteristics of hypersonic detonation wave ramjets p 659 N91-23168
The 2-D supersonic nozzle design p 660 N91-23176
Integrated multidisciplinary optimization of actively controlled fiber composite wings p 667 N91-23190
Development of a quiet supersonic wind tunnel with a cryogenic adaptive nozzle
[NASA-CR-186769] p 669 N91-23195
A computationally efficient modelling of laminar separation bubbles p 680 N91-23411
Soft hub for bearingless rotors
[NASA-CR-177586] p 654 N91-24198
Viscous design and analysis methods for transonic compressor blading
[AD-A232902] p 682 N91-24530
Nonlinear analysis of composite shear webs with holes and correlation with tests p 684 N91-24642
The role of analysis in the design and qualification of composite aircraft structures p 684 N91-24648
Influence of the refinement of structural calculation on aircraft qualification procedures p 684 N91-24649
DETECTION
Continuous wave laser for wind shear detection p 637 N91-24142
Status of 2 micron laser technology program p 637 N91-24143
Avionic laser multisensor program at Litton Aero Products p 637 N91-24144
Saberliner flight test for airborne wind shear forward looking detection and avoidance radar systems p 637 N91-24149
Signal processing techniques for clutter filtering and wind shear detection p 638 N91-24154
Feasibility study in crack detection in aircraft stiffened panels by pulse probing and deconvolution p 654 N91-24158
LIDAR studies on microbursts p 639 N91-24167
Thermodynamic Alerter for Microbursts (TAMP) p 640 N91-24179
Evaluation of cloud detection instruments and performance of laminar-flow leading-edge test articles during NASA Leading-Edge Flight-Test Program
[NASA-TP-2888] p 655 N91-24199
DETONATION WAVES
Performance characteristics of hypersonic detonation wave ramjets p 659 N91-23168
Analytical and experimental investigations of the oblique detonation wave engine concept p 660 N91-23169
DIFFRACTION
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 2: Development of theory for wing shielding
[NASA-CR-185192] p 688 N91-23849
DIGITAL SIMULATION
The design and simulation of an intelligent flight control system p 665 A91-40133
DIGITAL SYSTEMS
ADFCS and NOTAR (trademark): Two ways to fix flying qualities p 650 N91-23110
A field-deployable digital acoustic measurement system p 689 N91-24078
NASA-LaRc Flight-Critical Digital Systems Technology Workshop
[NASA-CP-10028] p 655 N91-24200
DIMENSIONAL ANALYSIS
An initial investigation into methods of computing transonic aerodynamic sensitivity coefficients
[NASA-CR-188192] p 629 N91-24099
DIRECTIONAL CONTROL
ADFCS and NOTAR (trademark): Two ways to fix flying qualities p 650 N91-23110
DISPLAY DEVICES
Precision runway monitor demonstration report
[AD-A232671] p 669 N91-23198
DOORS
Spot welded thermoplastic composite access door
[SME PAPER EM90-489] p 645 A91-36942
DOPPLER EFFECT
Measurement of clutter suppression using a Quadrahedral p 674 A91-37106
DOPPLER RADAR
Clutter rejection in Doppler weather radars used for airport wind shear detection p 685 A91-37104
Pulse Doppler signature of a rotary-wing aircraft p 643 A91-39756
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 2
[NASA-CP-10060-PT-2] p 636 N91-24140
CLASS: Coherent Lidar Airborne Shear Sensor. Windshear avoidance
[LMSC-F-415048] p 636 N91-24141
Continuous wave laser for wind shear detection p 637 N91-24142
Status of turbulence Prediction System's AWAS 3 p 637 N91-24146
Wind Shear radar program future plans p 637 N91-24151
Clutter modeling of the Denver Airport and surrounding areas p 638 N91-24152
Airborne radar simulation studies of the Denver July 11, 1988 microburst p 638 N91-24155
RADAR performance experiments p 639 N91-24168
Integrated data analysis of July 7, 1990 microburst p 685 N91-24170
Microburst avoidance simulation tests p 639 N91-24172
Orlando experiment p 640 N91-24177
Integration of the TDWR and LLWAS wind shear detection system p 640 N91-24178
DOUBLE BASE PROPELLANTS
Kinetic study of a homogeneous propellant primary flame, with and without additive p 671 A91-39690
DOWNBURSTS
An airborne FLIR detection and warning system for low altitude wind shear p 637 N91-24147
DOWNWASH
A vortex panel method for calculating aircraft downwash on parachute trajectories
[AIAA PAPER 91-0875] p 626 A91-40557
A vortex panel method for calculating aircraft downwash on parachute trajectories
[DE91-009764] p 627 N91-23085
Airborne rescue system
[NASA-CASE-ARC-11909-1] p 635 N91-23095
DRAG CHUTES
A dynamic analysis of the SRB parachute system
[AIAA PAPER 91-0838] p 670 A91-40555
DRAG REDUCTION
Dialogue on progress and issues in stability and transition research p 677 A91-39902
Passive laminar flow control of crossflow vorticity
[NASA-CASE-LAR-13563-1] p 679 N91-23410
Nonlinear Aerodynamics and the Design of Wing Tips
[NASA-CR-188044] p 630 N91-24105
DROP SIZE
Airblast atomization at conditions of low air velocity p 674 A91-37410
DROP TESTS
A numerical method for simulating drop test of landing gears p 648 A91-40174
Landing gear drop testing p 648 A91-40203
DROPS (LIQUIDS)
Water droplet impingement on airfoils and aircraft engine inlets for icing analysis p 634 A91-38543
DUCTED FLOW
Low-order panel method for internal flows p 625 A91-40225
Mixing of multiple jets with a confined subsonic crossflow. Summary of NASA-supported experiments and modeling
[NASA-TM-104412] p 662 N91-24202
DUMP COMBUSTORS
The effects of controlling vortex formation on the performance of a dump combustor p 672 N91-23270
DURABILITY
Environmental exposure effects on composite materials for commercial aircraft
[NASA-CR-187478] p 672 N91-24358
DYNAMIC CHARACTERISTICS
A dynamic analysis of the SRB parachute system
[AIAA PAPER 91-0838] p 670 A91-40555
An initial study into the influence of control stick characteristics on the handling qualities of a fly-by-wire helicopter p 651 N91-23122
DYNAMIC LOADS
Landing gear drop testing p 648 A91-40203
DYNAMIC MODELS
Normalized predictive deconvolution - Multichannel time-series applications to human dynamics p 686 A91-37584
A new system for unsteady aerodynamics of moving wall p 618 A91-38695
Further research on mechanical model for 'ground resonance' of helicopters p 665 A91-40164
Reacting shock waves in hypersonic propulsion applications p 629 N91-23174
DYNAMIC RESPONSE
Air surveying and data analysis for dynamic response of missiles at swept-back wing tip p 647 A91-40156
The nonlinear dynamic response analysis of the front windshield of Y12 under 'bird-impact' loads p 648 A91-40158
A numerical method for simulating drop test of landing gears p 648 A91-40174
Prediction of test spectrum for gunfire vibration p 666 A91-40175
Integrated multidisciplinary optimization of actively controlled fiber composite wings p 667 N91-23190
DYNAMIC STABILITY
Further research on mechanical model for 'ground resonance' of helicopters p 665 A91-40164
DYNAMIC STRUCTURAL ANALYSIS
A general method for rotordynamic analysis p 677 A91-39585

Modal analysis for fibre-carbon composite parts of an airplane p 679 A91-40157
The nonlinear dynamic response analysis of the front windshield of Y12 under 'bird-impact' loads p 648 A91-40158

DYNAMIC TESTS
Crashworthiness experiments p 638 N91-24161

E

EFFECTIVE PERCEIVED NOISE LEVELS
AGARD flight test techniques series. Volume 9: Aircraft exterior noise measurement and analysis techniques [AGARD-AG-300-VOL-9] p 689 N91-24843

EIGENVALUES
Robust eigenstructure assignment with structured state space uncertainty p 686 A91-39417
An evaluation of stability-based methods for transition of three-dimensional flows p 678 A91-39928

EJECTION INJURIES
The technical challenges of the crew escape technologies program p 612 A91-39392

EJECTION SEATS
Development and demonstration of CREST subsystems --- computer program for ejection seats p 646 A91-39380
Fighter escape system - The next step forward p 646 A91-39382
Ejection seat rocket catapult design for reduced G field influence p 646 A91-39385
The Minipac II ejection seat program p 647 A91-39390
The technical challenges of the crew escape technologies program p 612 A91-39392
Hardware-in-the-loop testing of the crest ejection seat control system p 647 A91-39394
Simulation of G(x) forces using horizontal impulse accelerators p 668 A91-39396
Canopy breaking system for non-delay pilot rescue p 647 A91-39398

EJECTION TRAINING
Simulation of G(x) forces using horizontal impulse accelerators p 668 A91-39396

EJECTORS
Static performance tests of a flight-type STOVL ejector [NASA-TM-104437] p 662 N91-24201

ELASTOMERS
Soft hub for bearingless rotors [NASA-CR-177586] p 654 N91-24198

ELECTRIC CHARGE
Prismatic sealed Ni-Cd battery for aircraft power p 657 A91-38178

ELECTRIC CONTROL
The electrical flight control system of A320 Airbus: A fault tolerant system [REPT-911-111-103] p 667 N91-23192

ELECTRIC PULSES
Flexural waves induced by electro-impulse deicing forces p 676 A91-38776

ELECTRODE MATERIALS
Prismatic sealed Ni-Cd battery for aircraft power p 657 A91-38178

ELECTROMAGNETIC SCATTERING
The planar elements method for computing the scattering field of flight vehicle p 674 A91-37052

ELECTRONIC CONTROL
On digital electronic control system of aircraft engine p 657 A91-38209

EMERGENCIES
National airspace system. Communications operational concept NAS-SR-136 [DOT/FAA/SE-91/1] p 640 N91-24185

EMERGENCY LOCATOR TRANSMITTERS
406 MHz ELT signal spectra for Sarsat p 643 A91-39778

EMISSION SPECTRA
Signal processing of aircraft flyover noise [NASA-CR-187546] p 690 N91-24845

ENERGY TECHNOLOGY
Activities report of the DLR [ISSN-0938-2194] p 691 N91-24086

ENERGY TRANSFER
An experimental study of an axisymmetric turbulent boundary layer disturbed by a periodic freestream p 626 N91-23078
Multi-heat addition turbine engine [NASA-CASE-LEW-15094-1] p 660 N91-23180

ENGINE AIRFRAME INTEGRATION
Developing and utilizing an Euler computational method for predicting the airframe/propulsion effects for an aft-mounted turboprop transport. Volume 1: Theory document [NASA-CR-181924-VOL-1] p 632 N91-24118
Developing and utilizing an Euler computational method for predicting the airframe/propulsion effects for an aft-mounted turboprop transport. Volume 2: User guide [NASA-CR-181924-VOL-2] p 632 N91-24119
A general multiblock Euler code for propulsion integration. Volume 1: Theory document [NASA-CR-187484-VOL-1] p 632 N91-24120
A general multiblock Euler code for propulsion integration. Volume 2: User guide for BCON, pre-processor for grid generation and GMBE [NASA-CR-187484-VOL-2] p 632 N91-24121
A general multiblock Euler code for propulsion integration. Volume 3: User guide for the Euler code [NASA-CR-187484-VOL-3] p 632 N91-24122

ENGINE CONTROL
Sensor failure detection for jet engines p 656 A91-37593
On digital electronic control system of aircraft engine p 657 A91-38209

ENGINE DESIGN
Cycle analysis for a supersonic through flow fan engine p 657 A91-38207
Toward automating the design of centrifugal impellers p 676 A91-38874
NASA aeropropulsion research in support of propulsion systems of the 21st century [NASA-TM-104403] p 627 N91-23083
A study of supersonic and hypersonic ramjet engines in France from 1950 to 1974 (application on combined cycle aircraft engines) p 658 N91-23149
Trajectory optimization considerations for ramjet engines p 658 N91-23151
Airbreathing propulsion for space transport: New concepts, special problems and attempts at solutions p 658 N91-23154
Analytical and experimental investigations of the oblique detonation wave engine concept p 660 N91-23169
Integration of propulsive systems: Selection and compromise [REPT-911-111-101] p 661 N91-23187
The certification of the aircraft integrated propulsive system [REPT-911-111-102] p 661 N91-23188
Small Engine Component Technology (SECT) studies [NASA-CR-175080] p 663 N91-24206
Small Engine Component Technology (SECT) study [NASA-CR-175081] p 663 N91-24207

ENGINE FAILURE
Sensor failure detection for jet engines p 656 A91-37593

ENGINE INLETS
Mach 4 testing of scramjet inlet models p 615 A91-37418
Experimental investigation on supersonic combustion p 657 A91-38203
A study of three dimensional turbulent boundary layer separation and vortex flow control using the reduced Navier Stokes equations [NASA-TM-104407] p 628 N91-23089
A design strategy for the use of vortex generators to manage inlet-engine distortion using computational fluid dynamics [NASA-TM-104436] p 633 N91-24131

ENGINE PARTS
Spot welded thermoplastic composite access door [SME PAPER EM90-489] p 645 A91-36942
NKK premium quality titanium master alloy p 672 A91-40425
Small Engine Component Technology (SECT) [NASA-CR-175078] p 662 N91-24205
Small Engine Component Technology (SECT) studies [NASA-CR-175080] p 663 N91-24206
Small Engine Component Technology (SECT) study [NASA-CR-175079] p 663 N91-24208
Improved silicon carbide for advanced heat engines [NASA-CR-182289] p 672 N91-24451

ENGINE TESTING LABORATORIES
A new facility to study three dimensional viscous flow and rotor-stator interaction in turbines p 682 N91-24336

ENGINE TESTS
Mach 4 testing of scramjet inlet models p 615 A91-37418
Small Engine Component Technology (SECT) [NASA-CR-175078] p 662 N91-24205
Small Engine Component Technology (SECT) studies [NASA-CR-175080] p 663 N91-24206
Small Engine Component Technology (SECT) study [NASA-CR-175079] p 663 N91-24208
An experimental evaluation of combustor liner materials for solid fuel ramjet testing p 670 N91-24289
Model 320-2: A compact advanced UAV turbojet p 663 N91-24292

ENTROPY
Entropy effects of hypersonic flow past blunt delta wings p 615 A91-37181

ENVIRONMENT EFFECTS
The 1989 high-speed civil transport studies [NASA-CR-4375] p 654 N91-24195

ENVIRONMENT PROTECTION
US industry enters the green maze --- new environmental regulations affecting aerospace companies p 685 A91-37049

ENVIRONMENTAL TESTS
Similarities and differences between environment tests and reliability tests in view of vibration p 665 A91-40166

EQUATIONS OF MOTION
Preference for an inertial degree of freedom describing the teeter motion of windturbine and helicopter rotors p 679 A91-40239
A dynamic analysis of the SRB parachute system [AIAA PAPER 91-0838] p 670 A91-40555

ERROR ANALYSIS
An engineering study of altitude determination deficiencies of the Service Aircraft Instrumentation Package (SAIP) [AD-A232055] p 656 N91-23145
Influence of the refinement of structural calculation on aircraft qualification procedures p 684 N91-24649

ESCAPE SYSTEMS
Development and demonstration of CREST subsystems --- computer program for ejection seats p 646 A91-39380
Fighter escape system - The next step forward p 646 A91-39382
The technical challenges of the crew escape technologies program p 612 A91-39392
Recent escape system parachute efforts at Douglas Aircraft Company p 635 A91-39393
Hardware-in-the-loop testing of the crest ejection seat control system p 647 A91-39394

EULER EQUATIONS OF MOTION
Block multigrid implicit solution of the Euler equations of compressible fluid flow p 616 A91-37836
Euler analysis of a High-Speed Civil Transport concept at Mach 3 p 624 A91-40217
Euler calculations of unsteady transonic flow in cascades [AIAA PAPER 91-1104] p 626 A91-40562
Block implicit multigrid solution of the Euler equations p 680 N91-23413
Aero-thermal investigation of a highly loaded transonic linear turbine guide vane cascade. A test case for inviscid and viscous flow computations [VKI-TN-174] p 680 N91-23437
An efficient hybrid scheme for the solution of rotational flow around advanced propellers p 629 N91-24104
Euler flow predictions for an oscillating cascade using a high resolution wave-split scheme [NASA-TM-104377] p 630 N91-24107
Developing and utilizing an Euler computational method for predicting the airframe/propulsion effects for an aft-mounted turboprop transport. Volume 1: Theory document [NASA-CR-181924-VOL-1] p 632 N91-24118
Developing and utilizing an Euler computational method for predicting the airframe/propulsion effects for an aft-mounted turboprop transport. Volume 2: User guide [NASA-CR-181924-VOL-2] p 632 N91-24119
A general multiblock Euler code for propulsion integration. Volume 1: Theory document [NASA-CR-187484-VOL-1] p 632 N91-24120
A general multiblock Euler code for propulsion integration. Volume 2: User guide for BCON, pre-processor for grid generation and GMBE [NASA-CR-187484-VOL-2] p 632 N91-24121
A general multiblock Euler code for propulsion integration. Volume 3: User guide for the Euler code [NASA-CR-187484-VOL-3] p 632 N91-24122

EUROPEAN AIRBUS
The certification of the aircraft integrated propulsive system [REPT-911-111-102] p 661 N91-23188

EXHAUST EMISSION
A CFD study of jet mixing in reduced flow areas for lower combustor emissions [NASA-TM-104411] p 661 N91-23185
The 1989 high-speed civil transport studies [NASA-CR-4375] p 654 N91-24195

EXHAUST GASES
Effect of exhaust plume/afterbody interaction on installed scramjet performance p 615 A91-37770

EXHAUST NOZZLES
Hot gas ingestion test results of a two-poster vectored thrust concept with flow visualization in the NASA Lewis 9- by 15-foot low speed wind tunnel [AIAA PAPER 90-2268] p 626 A91-40561

EXPERT SYSTEMS
The design and simulation of an intelligent flight control system p 665 A91-40133

A new architecture and expert system for aircraft design synthesis p 652 N91-23132
National remote computational flight research facility [NASA-CR-179432] p 668 N91-24210

F

F-14 AIRCRAFT
Variable Sweep Transition Flight Experiment (VSTFE): Unified Stability System (USS). Description and users' manual [NASA-CR-181918] p 634 N91-24139
F-16 AIRCRAFT
Demonstration of a Laser Ordnance Initiation System in an F-16 sled --- for flight crew escape system p 646 A91-39377
FABRICATION
Fabrication of engineering ceramics by injection molding p 674 A91-37375
FACTORIZATION
Implicit solvers for unstructured meshes [NASA-CR-187564] p 633 N91-24125
FAILURE ANALYSIS
Sensor failure detection for jet engines p 656 A91-37593
Nonlinear analysis of composite shear webs with holes and correlation with tests p 684 N91-24642
Influence of the refinement of structural calculation on aircraft qualification procedures p 684 N91-24649
FALSE ALARMS
Track initiation using MHT in dense environments --- Multiple Hypotesis Tracking p 674 A91-37141
Saberliner flight test for airborne wind shear forward looking detection and avoidance radar systems p 637 N91-24149
FATIGUE (MATERIALS)
Application of cyclic damage accumulation life prediction model to high temperature components p 681 N91-24309
Notched fatigue of single crystal PWA 1480 at turbine attachment temperatures p 682 N91-24310
FATIGUE LIFE
Modeling of creep-fatigue interaction effects on crack growth p 670 A91-38802
Composites for a widebody p 612 A91-39852
Calculation and experimental study on sonic fatigue life of aircraft structural panels p 648 A91-40162
Analytical methods for the qualification of helicopter structures p 684 N91-24650
FATIGUE TESTS
Computerized system for static and fatigue large scale structural tests: A case study [IAITIC-87-1007] p 681 N91-23522
FAULT TOLERANCE
The electrical flight control system of A320 Airbus: A fault tolerant system [REPT-911-111-103] p 667 N91-23192
FEEDBACK CONTROL
Automatic aircraft paint stripping [SME PAPER MS90-280] p 611 A91-36895
FIBER COMPOSITES
Supersonic flutter analysis of clamped symmetric composite panels using shear deformable finite elements p 675 A91-37847
Modal analysis for fibre-carbon composite parts of an airplane p 679 A91-40157
Integrated multidisciplinary optimization of actively controlled fiber composite wings p 667 N91-23190
FIGHTER AIRCRAFT
Toward enhanced fighter combat effectiveness p 645 A91-37050
Northrop advanced fighter crew protection system. I - Engineering development. II - System development, test and evaluation p 647 A91-39395
A study on sonic load of the vertical tail of F-7 aircraft p 648 A91-40171
Development of MIL-8785C into a handling qualities specification for a new European fighter aircraft p 666 N91-23114
The flying qualities influence of delay in the fighter pilot's cuing environment p 650 N91-23120
Agility: A rational development of fundamental metrics and their relationship to flying qualities p 651 N91-23129
X-31A at first flight p 651 N91-23131
Buffet induced structural/flight-control system interaction of the X-29A aircraft [NASA-TM-101735] p 652 N91-23133
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 1: Steady [AD-A233482] p 631 N91-24113
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 2: User manual for VORSTAB-2 [AD-A233483] p 631 N91-24114
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 3: Unsteady [AD-A233569] p 631 N91-24115
FINANCIAL MANAGEMENT
Aviation system capital investment plan [PB91-150268] p 644 N91-24189
FINITE DIFFERENCE THEORY
Calculation of low Reynolds number flows at high angles of attack p 624 A91-40218
FINITE ELEMENT METHOD
Three-dimensional finite element method analysis of turbulent flow over self-propelled slender bodies p 615 A91-37419
Sensitivity analysis, optimization, and data support in finite element systems p 677 A91-39230
Modal analysis of multistage gear systems coupled with gearbox vibrations [NASA-TM-103797] p 681 N91-23513
FINITE VOLUME METHOD
Cell centered and cell vertex multigrid schemes for the Navier-Stokes equations p 674 A91-37834
Transonic analysis and design using an improved grid p 624 A91-40137
FINNED BODIES
Inception length to a fully developed, fin-generated, shock-wave, boundary-layer interaction p 617 A91-37842
FIRE PREVENTION
Fire detection system for aircraft cargo bays p 655 A91-36755
Aircraft Command in Emergency Situations (ACES). Phase 1: Concept development [DOT/FAA/CT-90/21] p 636 N91-23097
FIRES
Aircraft Command in Emergency Situations (ACES). Phase 1: Concept development [DOT/FAA/CT-90/21] p 636 N91-23097
FLAME PROPAGATION
Subsonic and supersonic combustion using noncircular injectors p 674 A91-37414
FLAME TEMPERATURE
Kinetic study of a homogeneous propellant primary flame, with and without additive p 671 A91-39690
A CFD study of jet mixing in reduced flow areas for lower combustor emissions [NASA-TM-104411] p 661 N91-23185
FLAMES
Aerodynamics and stabilization of combustion of hydrogen jets injected into subsonic airflow p 629 N91-23164
FLAPS (CONTROL SURFACES)
A comparison between computation and experiment for flows around airfoil with slat and flap p 616 A91-37780
Blunt-nosed swept supercritical LFC wings without nose flaps p 622 A91-39936
FLAT PLATES
Cross-flow instability of 3-D boundary layers on a flat plate p 622 A91-39931
Visual study of boundary layer transition on rotating flat plate p 623 A91-39941
The experimental investigation of stability and receptivity of a swept-wing flow p 623 A91-39944
The effect of isolated roughness elements on transition in attachment-line flows p 678 A91-39959
Breaking down the delta wing vortex: The role of vorticity in the breakdown process [NASA-CR-188235] p 630 N91-24109
An experimental analysis of critical factors involved in the breakdown process of leading edge vortex flows [NASA-CR-188231] p 631 N91-24110
FLEXIBILITY
Microwave landing system modeling with application to air traffic control [NASA-TM-102832] p 636 N91-23099
FLEXIBLE BODIES
The transient dynamic performances of a rotor-SFDB system during passage through resonance p 678 A91-40130
FLEXIBLE WINGS
Analysis of circular elastic membrane wings p 625 A91-40472
FLEXING
Flexural waves induced by electro-impulse deicing forces p 676 A91-38776
Flexure vibration test method of aviation tube p 648 A91-40172
FLIGHT ALTITUDE
The influence of altitude and speed variations over the aircraft flight control response during the longitudinal nonlinear manoeuvres p 664 A91-36722
European studies to investigate the feasibility of using 1000 ft vertical separation minima above FL 290. I p 642 A91-38217
A test of the American Safety Flight Systems, Inc. prebreather/portable oxygen system [AD-A232723] p 636 N91-23100
FLIGHT CHARACTERISTICS
Improvement of atmospheric flight performance of a space vehicle through sensitivity minimization p 664 A91-37779
Flying Qualities [AGARD-CP-508] p 649 N91-23108
The art of flying qualities testing p 649 N91-23109
ADFCS and NOTAR (trademark): Two ways to fix flying qualities p 650 N91-23110
MIL-STD-1797 is not a cookbook p 650 N91-23111
Flying qualities experience on the AMX aircraft p 650 N91-23112
The development of alternate criteria for FBW handling qualities p 666 N91-23113
Development of MIL-8785C into a handling qualities specification for a new European fighter aircraft p 666 N91-23114
Do civil flying qualities requirements address military missions for off-the-shelf procurement p 650 N91-23115
Handling qualities of highly augmented unstable aircraft summary of an AGARD-FMP working group effort p 666 N91-23116
The handling qualities of the STOL and maneuver technology demonstrator from specification to flight test p 666 N91-23117
Metrics for roll response flying qualities p 650 N91-23118
The flying qualities influence of delay in the fighter pilot's cuing environment p 650 N91-23120
An initial study into the influence of control stick characteristics on the handling qualities of a fly-by-wire helicopter p 651 N91-23122
Flying qualities of the X-29 forward swept wing aircraft p 651 N91-23127
Agility: A rational development of fundamental metrics and their relationship to flying qualities p 651 N91-23129
Evaluation techniques for highly augmented aircraft [DLR-FB-90-35] p 667 N91-23191
FLIGHT CONDITIONS
Effects of canard position on the aerodynamic characteristics of a close-coupled canard configuration at low speed p 649 A91-40495
Theoretical and experimental performance of a solid fuel ramjet combustion cycle for hypersonic flight conditions p 660 N91-23170
FLIGHT CONTROL
The influence of altitude and speed variations over the aircraft flight control response during the longitudinal nonlinear manoeuvres p 664 A91-36722
A new method for estimating airspeed, attack angle and sideslip angle p 664 A91-37051
Practical considerations in optimal and 4-dimensional flight management computations p 686 A91-37585
Decoupled flight control via a model-following technique using the Euler operator p 664 A91-37595
Re-entry flight control of space plane using approximate perfect servo p 664 A91-37778
Lateral-direction tracking requirements from simulation data p 686 A91-39436
Testing the tiltrotor flight control system p 666 A91-40202
Flying Qualities [AGARD-CP-508] p 649 N91-23108
The art of flying qualities testing p 649 N91-23109
ADFCS and NOTAR (trademark): Two ways to fix flying qualities p 650 N91-23110
MIL-STD-1797 is not a cookbook p 650 N91-23111
Development of MIL-8785C into a handling qualities specification for a new European fighter aircraft p 666 N91-23114
Handling qualities of highly augmented unstable aircraft summary of an AGARD-FMP working group effort p 666 N91-23116
The flying qualities influence of delay in the fighter pilot's cuing environment p 650 N91-23120
Determination of decision-height windows for decelerating IMC approaches in helicopters p 667 N91-23124
Flying qualities of the X-29 forward swept wing aircraft p 651 N91-23127
Handling qualities evaluation for highly augmented helicopters p 651 N91-23128
Buffet induced structural/flight-control system interaction of the X-29A aircraft [NASA-TM-101735] p 652 N91-23133
Evaluation techniques for highly augmented aircraft [DLR-FB-90-35] p 667 N91-23191
The electrical flight control system of A320 Airbus: A fault tolerant system [REPT-911-111-103] p 667 N91-23192

NASA-LaRc Flight-Critical Digital Systems Technology Workshop
[NASA-CP-10028] p 655 N91-24200
Simulation evaluation of a speed-guidance law for Harrier approach transitions
[NASA-TM-102853] p 668 N91-24209
National remote computational flight research facility
[NASA-CR-179432] p 668 N91-24210

FLIGHT CREWS
Development and demonstration of CREST subsystems --- computer program for ejection seats
p 646 A91-39380
The technical challenges of the crew escape technologies program p 612 A91-39392
Hardware-in-the-loop testing of the crest ejection seat control system p 647 A91-39394
Northrop advanced fighter crew protection system. I - Engineering development. II - System development, test and evaluation p 647 A91-39395
The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the copilot/gunner, volume 2
[AD-A232907] p 641 N91-24187

FLIGHT HAZARDS
Aeronautical meteorology - Safety and economics of commercial air transports p 685 A91-38323
An airborne FLIR detection and warning system for low altitude wind shear p 637 N91-24147
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 1
[NASA-CP-10060-PT-1] p 639 N91-24166
Microburst avoidance simulation tests
p 639 N91-24172
Wind shear training applications for 91/135
p 639 N91-24173
NASA Langley flight test program p 639 N91-24175
Orlando experiment p 640 N91-24177
Thermodynamic Alerter for Microbursts (TAMP)
p 640 N91-24179
Estimate of heavy rain performance effect
p 640 N91-24182
Status of Sundstrand research p 640 N91-24183
Temperature lapse rate as an adjunct to wind shear detection p 640 N91-24184

FLIGHT MANAGEMENT SYSTEMS
Flight management systems --- Book
p 666 A91-40517
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 1
[NASA-CP-10060-PT-1] p 639 N91-24166
NASA Langley flight test program p 639 N91-24175

FLIGHT MECHANICS
Simplification of nonlinear indicial response models - Assessment for the two-dimensional airfoil case
p 664 A91-37771
Flight mechanics/air navigation research field. A 1990 Scientific report of the German Air and Space Research Organization
[ISSN-0720-7808] p 643 N91-23103
Handling qualities guidelines for the design of fly-by-wire flight control systems for transport aircraft
p 667 N91-23119
Integration of handling quality aspects into the aerodynamic design of modern unstable fighters
p 667 N91-23125
LIDAR studies on microbursts p 639 N91-24167

FLIGHT OPERATIONS
NASA Langley flight test program p 639 N91-24175
Orlando experiment p 640 N91-24177

FLIGHT PATHS
Coherent lidar airborne windshear sensor - Performance evaluation p 655 A91-39873
Microwave landing system modeling with application to air traffic control
[NASA-TM-102832] p 636 N91-23099

FLIGHT SAFETY
European studies to investigate the feasibility of using 1000 ft vertical separation minima above FL 290. I
p 642 A91-38217
Air travel - System relating flight safety, aircraft, and airports p 634 A91-38527
Near midair collisions as an indicator of general aviation collision risk p 635 N91-23096
Flight mechanics/air navigation research field. A 1990 Scientific report of the German Air and Space Research Organization
[ISSN-0720-7808] p 643 N91-23103
Aviation system capital investment plan
[PB91-150268] p 644 N91-24189

FLIGHT SIMULATION
Identification of pilot-vehicle dynamics from simulation and flight test p 664 A91-37598
One-on-one helicopter combat simulated by chess-type lookahead p 668 A91-37775
Handling qualities evaluation for highly augmented helicopters p 651 N91-23128
Analytical study of the effects of weight on Light Helicopter (LH) exposure to ground-based weapons
[AD-A232024] p 653 N91-23141
Evaluation techniques for highly augmented aircraft
[DLR-FB-90-35] p 667 N91-23191
Microburst avoidance simulation tests
p 639 N91-24172
Status of heavy rain tests p 640 N91-24180
MLS mathematical model validation study using airborne MLS data from Atlantic City International Airport Boeing 727 elevation shadowing flight tests
[DOT-FAA/CT-TN90/55] p 644 N91-24190
Evaluation of cloud detection instruments and performance of laminar-flow leading-edge test articles during NASA Leading-Edge Flight-Test Program
[NASA-TP-2888] p 655 N91-24199
Simulation evaluation of a speed-guidance law for Harrier approach transitions
[NASA-TM-102853] p 668 N91-24209

FLIGHT SIMULATORS
An investigation into the use of side-arm control for civil rotorcraft applications p 667 N91-23123
Handling qualities evaluation for highly augmented helicopters p 651 N91-23128
Wind shear training applications for 91/135
p 639 N91-24173

FLIGHT TESTS
Identification of pilot-vehicle dynamics from simulation and flight test p 664 A91-37598
Development of B-1 antenna measurement test bed
p 668 A91-37881
Effects of horizontal tail ice on longitudinal aerodynamic derivatives p 665 A91-38547
Flight tests show potential benefits of data link as primary communication medium p 643 A91-38577
Application of multiple-input/single-output analysis procedures to flight test data p 647 A91-39420
Investigations on flow instabilities on airfoils by means of piezofoil-arrays p 621 A91-39911
Correlation of boundary layer stability analysis with flight transition data p 621 A91-39929
Application of identification method of modal parameters to flight flutter test p 665 A91-40167
Flight mechanics/air navigation research field. A 1990 Scientific report of the German Air and Space Research Organization
[ISSN-0720-7808] p 643 N91-23103
Differential GPS terminal area test results
[AD-A232668] p 644 N91-23106
The art of flying qualities testing p 649 N91-23109
ADFCS and NOTAR (trademark): Two ways to fix flying qualities p 650 N91-23110
An investigation into the use of side-arm control for civil rotorcraft applications p 667 N91-23123
B-1B high AOA testing in the evaluation of a stall inhibitor system p 651 N91-23126
Handling qualities evaluation for highly augmented helicopters p 651 N91-23128
X-31A at first flight p 651 N91-23131
Long time measurements of landing gear loads on SAAB SF-340 commuter aircraft
[FFA-TN-1990-53] p 653 N91-23138
Flow visualization study of a 1/48-scale AFTI/F111 model to investigate horizontal tail flow disturbances
[NASA-TM-101698] p 633 N91-24128
Transonic Symposium: Theory, Application and Experiment, volume 2
[NASA-CP-3020-VOL-2] p 634 N91-24132
Laminar-flow flight experiments p 634 N91-24135
Computational support of the X-29A Advanced Technology Demonstrator flight experiment
p 653 N91-24137
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 1
[NASA-CP-10060-PT-1] p 639 N91-24166
Integrated data analysis of July 7, 1990 microburst
p 685 N91-24170
NASA Langley flight test program p 639 N91-24175
Lightning protection requirements for aircraft: A proposed specification
[RAE-TM-FS(F)-632-ISSUE-1-R] p 641 N91-24186
MLS mathematical model validation study using airborne MLS data from Atlantic City International Airport Boeing 727 elevation shadowing flight tests
[DOT-FAA/CT-TN90/55] p 644 N91-24190
Static performance tests of a flight-type STOVL ejector
[NASA-TM-104437] p 662 N91-24201
National remote computational flight research facility
[NASA-CR-179432] p 668 N91-24210
Analytical methods for the qualification of helicopter structures p 684 N91-24650
AGARD flight test techniques series. Volume 9: Aircraft exterior noise measurement and analysis techniques
[AGARD-AG-300-VOL-9] p 689 N91-24843
Laboratory test and acoustic analysis of cabin treatment for propfan test assessment aircraft
[NASA-CR-182075] p 690 N91-24844

FLIGHT VEHICLES
The planar elements method for computing the scattering field of flight vehicle p 674 A91-37052

FLIR DETECTORS
Status of NASA's IR wind shear detection research
p 637 N91-24145
An airborne FLIR detection and warning system for low altitude wind shear p 637 N91-24147

FLOW DISTORTION
Vortex shedding and lock-on in bluff body wakes
p 675 A91-38689
Effects of inlet distortion on the development of secondary flows in a subsonic axial inlet compressor rotor
[NASA-TM-104356] p 660 N91-23179
A design strategy for the use of vortex generators to manage inlet-engine distortion using computational fluid dynamics
[NASA-TM-104436] p 633 N91-24131

FLOW DISTRIBUTION
Experimental investigation of loading effects on compressor trailing-edge flowfields p 615 A91-37420
Numerical investigation of airfoil/jet/fuselage-undersurface flowfields in ground effect p 617 A91-38541
Flow around an unsteady thin wing close to curved ground p 620 A91-39744
Experiments on the unsteadiness associated with a ground vortex p 624 A91-40220
Low-order panel method for internal flows
p 625 A91-40225
Effects of canard position on the aerodynamic characteristics of a close-coupled canard configuration at low speed p 649 A91-40495
Hot gas ingestion test results of a two-poster vectored thrust concept with flow visualization in the NASA Lewis 9- by 15-foot low speed wind tunnel
[AIAA PAPER 90-2268] p 626 A91-40561
An experimental study of an axisymmetric turbulent boundary layer disturbed by a periodic freestream
p 626 N91-23078
Interferometric investigation of supersonic flow fields with shock-shock interactions p 627 N91-23082
Supersonic-hypersonic inlet studies for aerospaceplane p 659 N91-23160
Reacting shock waves in hypersonic propulsion applications p 629 N91-23174
Viscous three-dimensional analyses for nozzles for hypersonic propulsion p 629 N91-23175
Effects of inlet distortion on the development of secondary flows in a subsonic axial inlet compressor rotor
[NASA-TM-104356] p 660 N91-23179
IAI hypersonic wind tunnel
[IAITIC-87-1006] p 668 N91-23194
The effects of controlling vortex formation on the performance of a dump combustor p 672 N91-23270
An experimental investigation of vortex pair interaction with a clean or contaminated free surface
p 680 N91-23419
Aero-thermal investigation of a highly loaded transonic linear turbine guide vane cascade. A test case for inviscid and viscous flow computations
[VKI-TN-174] p 680 N91-23437
Computation of inlet reference plane flow-field for a subscale free-jet forebody/inlet model and comparison to experimental data
[AD-A232101] p 680 N91-23445
The propagation of acoustic disturbances in the transonic flow fields of wings
[ESA-TT-1126] p 689 N91-23854
Aerodynamic interactions between bodies in relative motion p 629 N91-24103
Nonlinear Aerodynamics and the Design of Wing Tips
[NASA-CR-188044] p 630 N91-24105
The computation of induced drag with nonplanar and deformed wakes p 630 N91-24106
Breaking down the delta wing vortex: The role of vorticity in the breakdown process
[NASA-CR-188235] p 630 N91-24109
An experimental analysis of critical factors involved in the breakdown process of leading edge vortex flows
[NASA-CR-188231] p 631 N91-24110
Unsteady Navier-Stokes solutions for a low aspect ratio delta wing
[AD-A233201] p 631 N91-24112

A general multiblock Euler code for propulsion integration. Volume 1: Theory document
[NASA-CR-187484-VOL-1] p 632 N91-24120
Theoretical evaluation of engine auxiliary inlet design for supersonic V/STOL aircraft
[NASA-CR-187098] p 633 N91-24123
A design strategy for the use of vortex generators to manage inlet-engine distortion using computational fluid dynamics
[NASA-TM-104436] p 633 N91-24131
Mixing of multiple jets with a confined subsonic crossflow. Summary of NASA-supported experiments and modeling
[NASA-TM-104412] p 662 N91-24202
Advanced computational models for analyzing high speed propulsive flowfields p 686 N91-24291
Average-passage flow model development p 682 N91-24338
Effects of wing sweep on in-flight boundary-layer transition for a laminar flow wing at Mach numbers from 0.60 to 0.79
[NASA-TM-101701] p 683 N91-24555
Effects of wing sweep on boundary-layer transition for a smooth F-14A wing at Mach numbers from 0.700 to 0.825
[NASA-TM-101712] p 683 N91-24556

FLOW GEOMETRY
Forebody vortex control with the unsteady bleed technique p 617 A91-37859
Mixing of multiple jets with a confined subsonic crossflow. Summary of NASA-supported experiments and modeling
[NASA-TM-104412] p 662 N91-24202

FLOW MEASUREMENT
Effects of inlet distortion on the development of secondary flows in a subsonic axial inlet compressor rotor
[NASA-TM-104356] p 660 N91-23179
An experimental analysis of critical factors involved in the breakdown process of leading edge vortex flows
[NASA-CR-188231] p 631 N91-24110

FLOW STABILITY
The stability to two-dimensional wakes and shear layers at high Mach numbers p 614 A91-36452
Dialogue on progress and issues in stability and transition research p 677 A91-39902
Investigations on flow instabilities on airfoils by means of piezofoil-arrays p 621 A91-39911
On the instability of hypersonic flow past a wedge p 621 A91-39922
On the stability of swept wing laminar boundary layers including curvature effects p 622 A91-39933
Blunt-nosed swept supercritical LFC wings without nose flaps p 622 A91-39936
The experimental investigation of stability and receptivity of a swept-wing flow p 623 A91-39944
Direct numerical study of crossflow instability p 678 A91-39956

FLOW THEORY
New methods in the theory of subsonic flows past thin airfoil configurations p 614 A91-36699

FLOW VELOCITY
Airblast atomization at conditions of low air velocity p 674 A91-37410
Three-dimensional composite velocity solutions for subsonic/transonic flow p 616 A91-37841
Effects of inlet distortion on the development of secondary flows in a subsonic axial inlet compressor rotor
[NASA-TM-104356] p 660 N91-23179

FLOW VISUALIZATION
Asymmetric vortices on a slender body of revolution p 616 A91-37827
Quantitative analysis of flow visualizations in ONERA water tunnels p 677 A91-39694
Further experiments on vortex formation around an oscillating and translating airfoil at large incidences p 620 A91-39738
Visual study of boundary layer transition on rotating flat plate p 623 A91-39941
Visualisation of boundary layer transition p 623 A91-39964
Hot gas ingestion test results of a two-poster vectored thrust concept with flow visualization in the NASA Lewis 9- by 15-foot low speed wind tunnel
[AIAA PAPER 90-2268] p 626 A91-40561
Aero-thermal investigation of a highly loaded transonic linear turbine guide vane cascade. A test case for inviscid and viscous flow computations
[VKI-TN-174] p 680 N91-23437
Flow visualization study of a 1/48-scale AFTI/F111 model to investigate horizontal tail flow disturbances
[NASA-TM-101698] p 633 N91-24128

FLUID DYNAMICS
Status of heavy rain tests p 640 N91-24180

FLUID FLOW
Vibration behavior of a labyrinth seal with through-flow p 679 A91-40241
An efficient hybrid scheme for the solution of rotational flow around advanced propellers p 629 N91-24104

FLUID MECHANICS
Development of a quiet supersonic wind tunnel with a cryogenic adaptive nozzle
[NASA-CR-186769] p 669 N91-23195

FLUID-SOLID INTERACTIONS
Numerical analysis of solid-fuel interactive vibration on an aircraft integral tank p 648 A91-40161

FLUTTER
An efficient hybrid scheme for the solution of rotational flow around advanced propellers p 629 N91-24104

FLUTTER ANALYSIS
Asymptotic theory of bending-torsion flutter of high aspect ratio wing in the torsion controlled domain p 675 A91-37846
Supersonic flutter analysis of clamped symmetric composite panels using shear deformable finite elements p 675 A91-37847
Application of identification method of modal parameters to flight flutter test p 665 A91-40167
Integration of vibration test and flutter analysis - A brief introduction to 'a real-time flutter analysis system' p 665 A91-40168
Transonic flutter analysis of 2-D airfoils with 2 degrees of freedom p 665 A91-40169
Flow visualization study of a 1/48-scale AFTI/F111 model to investigate horizontal tail flow disturbances
[NASA-TM-101698] p 633 N91-24128

FLY BY WIRE CONTROL
A320 - First of the computer-age aircraft p 645 A91-36354
Aircraft electrical system computer simulation p 657 A91-38037
Flying qualities experience on the AMX aircraft p 650 N91-23112
The development of alternate criteria for FBW handling qualities p 666 N91-23113
Handling qualities guidelines for the design of fly-by-wire flight control systems for transport aircraft p 667 N91-23119
An initial study into the influence of control stick characteristics on the handling qualities of a fly-by-wire helicopter p 651 N91-23122
An investigation into the use of side-arm control for civil rotorcraft applications p 667 N91-23123

FORCED VIBRATION
Euler flow predictions for an oscillating cascade using a high resolution wave-split scheme
[NASA-TM-104377] p 630 N91-24107

FOREBODIES
Forebody vortex control with the unsteady bleed technique p 617 A91-37859

FORMAT
An overview of information resources in aviation p 690 N91-24091

FORMING TECHNIQUES
Metal matrix composite vertical tail fabrication
[SME PAPER EM90-438] p 611 A91-36875

FRACTURE MECHANICS
Fatigue crack growth modeling at elevated temperature using fracture mechanics p 671 A91-38812
Identification strategies for crack shape determination in rotors p 679 A91-40234

FRACTURES (MATERIALS)
How to know CMC
[REPT-911-430-130] p 672 N91-23262

FREE FLIGHT
Aerodynamics at the speed of sound p 621 A91-39900

FREE FLOW
An experimental study of an axisymmetric turbulent boundary layer disturbed by a periodic freestream p 626 N91-23078
Computation of inlet reference plane flow-field for a subscale free-jet forebody/inlet model and comparison to experimental data
[AD-A232101] p 680 N91-23445

FREE JETS
Computation of inlet reference plane flow-field for a subscale free-jet forebody/inlet model and comparison to experimental data
[AD-A232101] p 680 N91-23445

FREQUENCY HOPPING
SATURN: The next generation radio for NATO p 682 N91-24475

FUEL COMBUSTION
Theoretical and experimental performance of a solid fuel ramjet combustion cycle for hypersonic flight conditions p 660 N91-23170
The effects of controlling vortex formation on the performance of a dump combustor p 672 N91-23270
Fuel-rich, catalytic reaction experimental results
[NASA-TM-104423] p 662 N91-24203

FUEL CONSUMPTION
Long-range aircraft are in demand p 611 A91-36353
Commercial aircraft fuel efficiency potential through 2010 p 645 A91-38127
Trajectory optimization considerations for ramjet engines p 658 N91-23151
Small Engine Component Technology (SECT) study. Program report
[NASA-CR-175077] p 662 N91-24204

FUEL INJECTION
Analytical and experimental investigations of the oblique detonation wave engine concept p 660 N91-23169

FUEL PUMPS
Advanced aircraft secondary power system design p 656 A91-38007

FUEL SPRAYS
Airblast atomization at conditions of low air velocity p 674 A91-37410

FUEL TANKS
Numerical analysis of solid-fuel interactive vibration on an aircraft integral tank p 648 A91-40161

FUEL TESTS
An experimental evaluation of combustor liner materials for solid fuel ramjet testing p 670 N91-24289

FULL SCALE TESTS
Full-scale demonstration tests of cabin noise reduction using active vibration control p 646 A91-38549

FUNCTIONAL DESIGN SPECIFICATIONS
Lightning protection requirements for aircraft: A proposed specification
[RAE-TM-FS(F)-632-ISSUE-1-R] p 641 N91-24186

FUSELAGES
Rotor-fuselage dynamics of helicopter air and ground resonance p 645 A91-36357
Moulded Mustang p 612 A91-39854
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 5: Propagation of propeller tone noise through a fuselage boundary layer
[NASA-CR-185195] p 689 N91-23852
Noise inside aircraft fuselages subjected to airborne excitations
[REPT-911-111-104] p 689 N91-23853
Aerodynamic interactions between bodies in relative motion p 629 N91-24103
Analytical methods for the qualification of helicopter structures p 684 N91-24650

G

GAME THEORY
One-on-one helicopter combat simulated by chess-type lookahead p 668 A91-37775

GAS ATOMIZATION
Airblast atomization at conditions of low air velocity p 674 A91-37410

GAS CHROMATOGRAPHY
Detection of traces of water in aviation kerosenes by gas chromatography p 670 A91-37182

GAS DETECTORS
Advanced airborne oxygen sensors p 655 A91-39387

GAS DISCHARGE TUBES
Radioluminescent (RL) lighting system development program
[DE91-009743] p 679 N91-23381

GAS DISSOCIATION
Numerical study of hypersonic dissociated air past blunt bodies p 616 A91-37835

GAS FLOW
Airblast atomization at conditions of low air velocity p 674 A91-37410

GAS GENERATORS
Subsonic and supersonic combustion using noncircular injectors p 674 A91-37414
Advanced airborne oxygen sensors p 655 A91-39387

GAS JETS
Aerodynamics and stabilization of combustion of hydrogen jets injected into subsonic airflow p 629 N91-23164

GAS TURBINE ENGINES
Automated CAD design for sculptured airfoil surfaces
[SME PAPER MS90-744] p 673 A91-36943
Residual stress control in developing processes for the manufacture of compressor blades for gas turbine engines p 674 A91-37269
Application of path-independent integrals to elevated temperature crack growth p 671 A91-38819
Design and development of aviation gas turbine engines --- Russian book p 657 A91-39201
Non metallic materials for gas turbine engines - Are they real? p 671 A91-40178

Research on aerodynamic control of blade tip clearance flow in air-cooled turbine
[DE91-764223] p 660 N91-23182
Water-cooling technique of high temperature gas turbine blade
[DE91-764238] p 681 N91-23506
Mixing of multiple jets with a confined subsonic crossflow. Summary of NASA-supported experiments and modeling
[NASA-TM-104412] p 662 N91-24202
Fuel-rich, catalytic reaction experimental results
[NASA-TM-104423] p 662 N91-24203
Small Engine Component Technology (SECT) study
[NASA-CR-175081] p 663 N91-24207
Notched fatigue of single crystal PWA 1480 at turbine attachment temperatures p 682 N91-24310
Coolant side heat transfer with rotation. Task 3 report: Application of computational fluid dynamics
[NASA-CR-182109] p 683 N91-24551

GAS TURBINES
Multi-heat addition turbine engine
[NASA-CASE-LEW-15094-1] p 660 N91-23180
Simulation of a combined-cycle engine
[NASA-CR-188232] p 683 N91-24583

GAS-SOLID INTERFACES
Variable-property effects in supersonic wedge flow p 616 A91-37832

GASIFICATION
Theoretical and experimental performance of a solid fuel ramjet combustion cycle for hypersonic flight conditions p 660 N91-23170

GEARS
Modal analysis of multistage gear systems coupled with gearbox vibrations
[NASA-TM-103797] p 681 N91-23513

GEOMETRICAL ACOUSTICS
The propagation of acoustic disturbances in the transonic flow fields of wings
[ESA-TT-1126] p 689 N91-23854

GEOTECHNICAL FABRICS
Literature review on geotextiles to improve pavements for general aviation airports
[AD-A232871] p 669 N91-23199

GLOBAL POSITIONING SYSTEM
Differential GPS terminal area test results
[AD-A232668] p 644 N91-23106

GOERTLER INSTABILITY
On the Goertler vortex instability mechanism at hypersonic speeds p 623 A91-39940
Theoretical study of Goertler vortices - Linear stability approach p 623 A91-39950

GOVERNMENT/INDUSTRY RELATIONS
US industry enters the green maze --- new environmental regulations affecting aerospace companies p 685 A91-37049

GRAPHITE-EPOXY COMPOSITES
The design, manufacture, and test of a one-piece thermoplastic wing rib for tiltrotor aircraft
[SME PAPER EM90-665] p 645 A91-36940
Study of thermal-expansion-molded, graphite-epoxy hat-stiffened sandwich panels p 675 A91-37845
Development and demonstration of CREST subsystems --- computer program for ejection seats p 646 A91-39380
Environmental exposure effects on composite materials for commercial aircraft
[NASA-CR-187478] p 672 N91-24358

GRAVITATIONAL EFFECTS
Ejection seat rocket catapult design for reduced G field influence p 646 A91-39385

GREEN'S FUNCTIONS
The breakdown of the linearized theory and the role of quadrupole sources in transonic rotor acoustics p 688 A91-39749
Procedure for determination of three-dimensional wind tunnel wall interferences and wall adaptation in compressible subsonic flow using measured wall pressures
[DLR-FB-90-46] p 628 N91-23088
Feasibility study in crack detection in aircraft stiffened panels by pulse probing and deconvolution p 654 N91-24158

GRID GENERATION (MATHEMATICS)
Developing and utilizing an Euler computational method for predicting the airframe/propulsion effects for an aft-mounted turboprop transport. Volume 1: Theory document
[NASA-CR-181924-VOL-1] p 632 N91-24118
A general multiblock Euler code for propulsion integration. Volume 1: Theory document
[NASA-CR-187484-VOL-1] p 632 N91-24120
A general multiblock Euler code for propulsion integration. Volume 2: User guide for BCON, pre-processor for grid generation and GMBE
[NASA-CR-187484-VOL-2] p 632 N91-24121
A general multiblock Euler code for propulsion integration. Volume 3: User guide for the Euler code
[NASA-CR-187484-VOL-3] p 632 N91-24122

GROUND BASED CONTROL
Microburst avoidance simulation tests p 639 N91-24172

GROUND EFFECT (AERODYNAMICS)
Numerical investigation of airfoil/jet/fuselage-undersurface flowfields in ground effect p 617 A91-38541
Flow around an unsteady thin wing close to curved ground p 620 A91-39744
Suckdown, fountain lift, and pressures induced on several tandem jet V/STOL configurations
[NASA-TM-102817] p 630 N91-24108

GROUND EFFECT (COMMUNICATIONS)
Clutter modeling of the Denver Airport and surrounding areas p 638 N91-24152
Radar simulation program upgrade and algorithm development p 638 N91-24153

GROUND RESONANCE
Rotor-fuselage dynamics of helicopter air and ground resonance p 645 A91-36357
Ground resonance of a helicopter with inter-connected blades p 645 A91-36360
Further research on mechanical model for 'ground resonance' of helicopters p 665 A91-40164

GROUND TESTS
Identification of nacelle modes from airplane GVT results p 648 A91-40170
Testing the tiltrotor flight control system p 666 A91-40202

GROUND WIND
TDWR information on the flight deck p 640 N91-24176
Integration of the TDWR and LLWAS wind shear detection system p 640 N91-24178

GROUND-AIR-GROUND COMMUNICATION
National airspace system. Communications operational concept NAS-SR-136
[DOT/FAA/SE-91/1] p 640 N91-24185

GUIDE VANES
Aero-thermal investigation of a highly loaded transonic linear turbine guide vane cascade. A test case for inviscid and viscous flow computations
[VKI-TN-174] p 680 N91-23437

GUNFIRE
Prediction of test spectrum for gunfire vibration p 666 A91-40175

GUST LOADS
Design of aircraft wings subjected to gust loads - A safety index based approach p 675 A91-37851

GUSTS
Integrated multidisciplinary optimization of actively controlled fiber composite wings p 667 N91-23190

H

HARDWARE
Hardware-in-the-loop testing of the crest ejection seat control system p 647 A91-39394

HARMONIC MOTION
Euler flow predictions for an oscillating cascade using a high resolution wave-split scheme
[NASA-TM-104377] p 630 N91-24107

HARRIER AIRCRAFT
Simulation evaluation of a speed-guidance law for Harrier approach transitions
[NASA-TM-102853] p 668 N91-24209

HAZE
Evaluation of cloud detection instruments and performance of laminar-flow leading-edge test articles during NASA Leading-Edge Flight-Test Program
[NASA-TP-2888] p 655 N91-24199

HEAD (ANATOMY)
The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the copilot/gunner, volume 1
[AD-A233349] p 641 N91-24188

HEAD-UP DISPLAYS
Lateral-direction tracking requirements from simulation data p 686 A91-39436
Along for the ride? --- computer-automated aviation overview p 656 A91-40550

HEAT EXCHANGERS
Compact heat exchanger for an inverse components engine p 659 N91-23157

HEAT RESISTANT ALLOYS
Non metallic materials for gas turbine engines - Are they real? p 671 A91-40178
NKK premium quality titanium master alloy p 672 A91-40425

HEAT TRANSFER
Variable-property effects in supersonic wedge flow p 616 A91-37832
Viscous three-dimensional analyses for nozzles for hypersonic propulsion p 629 N91-23175
Multi-heat addition turbine engine
[NASA-CASE-LEW-15094-1] p 660 N91-23180
Coolant side heat transfer with rotation. Task 3 report: Application of computational fluid dynamics
[NASA-CR-182109] p 683 N91-24551

HELICOPTER CONTROL
ADFCS and NOTAR (trademark): Two ways to fix flying qualities p 650 N91-23110
Handling qualities evaluation for highly augmented helicopters p 651 N91-23128

HELICOPTER DESIGN
Ground resonance of a helicopter with inter-connected blades p 645 A91-36360
Comanche - Tomorrow's high-tech helicopter p 649 A91-40254

HELICOPTER PERFORMANCE
Rotor-fuselage dynamics of helicopter air and ground resonance p 645 A91-36357
Unsteady, frequency-domain analysis of helicopter non-rotating lifting surfaces p 613 A91-36359

HELICOPTERS
Further research on mechanical model for 'ground resonance' of helicopters p 665 A91-40164
A study of the noise mechanisms of transonic blade-vortex interactions
[NASA-CR-188199] p 627 N91-23084
Airborne rescue system
[NASA-CASE-ARC-11909-1] p 635 N91-23095
An initial study into the influence of control stick characteristics on the handling qualities of a fly-by-wire helicopter p 651 N91-23122
Determination of decision-height windows for decelerating IMC approaches in helicopters p 667 N91-23124
Air ambulance helicopter operational analysis
[DOT/FAA/RD-91/7] p 652 N91-23134
AGARD highlights 91/1, March 1991
[AGARD-HIGHLIGHTS-91/1] p 691 N91-24084
Analytical methods for the qualification of helicopter structures p 684 N91-24650

HELMETS
Northrop advanced fighter crew protection system. I - Engineering development. II - System development, test and evaluation p 647 A91-39395

HELMHOLTZ RESONATORS
Laboratory test and acoustic analysis of cabin treatment for propfan test assessment aircraft
[NASA-CR-182075] p 690 N91-24844

HIGH GRAVITY ENVIRONMENTS
Simulation of G(x) forces using horizontal impulse accelerators p 668 A91-39396

HIGH RESOLUTION
Relative effectiveness of 2-D vs. 1-D high resolution microwave imageing p 641 A91-37094
Euler flow predictions for an oscillating cascade using a high resolution wave-split scheme
[NASA-TM-104377] p 630 N91-24107

HIGH REYNOLDS NUMBER
Simulation of the flow past an impulsively started cylinder using a discrete vortex method
[AD-A233066] p 683 N91-24533

HIGH SPEED
Technology needs for high-speed rotorcraft
[NASA-CR-177578] p 652 N91-23136
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 2: Development of theory for wing shielding
[NASA-CR-185192] p 688 N91-23849
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 3: Application of theory for blade loading, wakes, noise, and wing shielding
[NASA-CR-185193] p 688 N91-23850
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 4: Computer user's manual for UAAP turboprop aeroacoustic code
[NASA-CR-185194] p 688 N91-23851
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 5: Propagation of propeller tone noise through a fuselage boundary layer
[NASA-CR-185195] p 689 N91-23852
Advanced computational models for analyzing high speed propulsive flowfields p 686 N91-24291

HIGH TEMPERATURE
Fatigue crack growth modeling at elevated temperature using fracture mechanics p 671 A91-38812
Advanced thermally stable jet fuels development program annual report. Volume 3: Fuel lubricity
[AD-A232793] p 673 N91-24453

HIGH TEMPERATURE GASES
An isentropic compression-heated Ludweig tube transient wind tunnel p 673 A91-36450

Hot gas ingestion test results of a two-poster vectored thrust concept with flow visualization in the NASA Lewis 9- by 15-foot low speed wind tunnel
[AIAA PAPER 90-2268] p 626 A91-40561
Suckdown, fountain lift, and pressures induced on several tandem jet V/STOL configurations
[NASA-TM-102817] p 630 N91-24108

HIGH TEMPERATURE TESTS
Application of path-independent integrals to elevated temperature crack growth p 671 A91-38819

HISTORIES
AGARD highlights 91/1, March 1991
[AGARD-HIGHLIGHTS-91/1] p 691 N91-24084

HOLOGRAPHIC INTERFEROMETRY
Interferometric investigation of supersonic flow fields with shock-shock interactions p 627 N91-23082

HONEYCOMB STRUCTURES
Application of acoustically treated honeycomb sandwich panels in noise control of aircraft cabin p 648 A91-40160

HORIZONTAL FLIGHT
Optimization of rotor performance in hover using a free wake analysis p 646 A91-38548

HOVERING
New developments in the dynamic aeroelastic stability study of rotor blades p 673 A91-36698
Optimization of rotor performance in hover using a free wake analysis p 646 A91-38548
Technology needs for high-speed rotorcraft
[NASA-CR-177578] p 652 N91-23136
Simulation evaluation of a speed-guidance law for Harrier approach transitions
[NASA-TM-102853] p 668 N91-24209

HOVERING STABILITY
Stability of hingeless rotors in hover using three-dimensional unsteady aerodynamics p 663 A91-36358

HUMAN FACTORS ENGINEERING
Identification of pilot-vehicle dynamics from simulation and flight test p 664 A91-37598
Aircraft design for maintainability p 612 A91-38546
Deployment optimization and human factors considerations for low-altitude troop parachutes
[AIAA PAPER 91-0889] p 635 A91-40559
Program plans for aviation safety research
[NIAR-90-32] p 638 N91-24157

HUMAN PERFORMANCE
A test of the American Safety Flight Systems, Inc. prebreather/portable oxygen system
[AD-A232723] p 636 N91-23100

HYDRAULIC EQUIPMENT
Advanced aircraft secondary power system design p 656 A91-38007
Flexure vibration test method of aviation tube p 648 A91-40172

HYDRAULIC TEST TUNNELS
Quantitative analysis of flow visualizations in ONERA water tunnels p 677 A91-39694

HYDROCARBON FUELS
Fuel-rich, catalytic reaction experimental results
[NASA-TM-104423] p 662 N91-24203

HYDRODYNAMICS
Passive laminar flow control of crossflow vorticity
[NASA-CASE-LAR-13563-1] p 679 N91-23410

HYDROGEN
Aerodynamics and stabilization of combustion of hydrogen jets injected into subsonic airflow p 629 N91-23164

HYDROGEN ENGINES
Compact heat exchanger for an inverse components engine p 659 N91-23157

HYPERSONIC AIRCRAFT
Accent on hypersonic p 669 A91-36625
Navigation, guidance, and trajectory optimization for hypersonic vehicles p 644 N91-23150
National remote computational flight research facility
[NASA-CR-179432] p 668 N91-24210
Advanced Hypervelocity Aerophysics Facility Workshop
[NASA-CP-10031] p 669 N91-24211

HYPERSONIC BOUNDARY LAYER
Real gas effects on hypersonic boundary-layer stability p 614 A91-36453
Discontinuous solutions for a three-dimensional hypersonic boundary layer with interaction p 614 A91-37176
On the Goertler vortex instability mechanism at hypersonic speeds p 623 A91-39940

HYPERSONIC FLIGHT
Hypersonic Combined Cycle Propulsion
[AGARD-CP-479] p 657 N91-23147
Hypersonic propulsion: Past and present p 657 N91-23148
A study of supersonic and hypersonic ramjet engines in France from 1950 to 1974 (application on combined cycle aircraft engines) p 658 N91-23149
Trajectory optimization considerations for ramjet engines p 658 N91-23151
Hypersonic propulsion: Status and challenge p 658 N91-23153
Airbreathing propulsion for space transport: New concepts, special problems and attempts at solutions p 658 N91-23154
Turbojet potential for hypersonic flight p 658 N91-23155
Compact heat exchanger for an inverse components engine p 659 N91-23157
Design considerations for combined air breathing-rocket propulsion systems
[AIAA-90-0098] p 659 N91-23158
Some aspects of shock-wave boundary layer interaction relevant to intake flows p 628 N91-23161
Analytical and experimental investigations of the oblique detonation wave engine concept p 660 N91-23169
Theoretical and experimental performance of a solid fuel ramjet combustion cycle for hypersonic flight conditions p 660 N91-23170
Reacting shock waves in hypersonic propulsion applications p 629 N91-23174
Viscous three-dimensional analyses for nozzles for hypersonic propulsion p 629 N91-23175
IAI hypersonic wind tunnel
[IAITIC-87-1006] p 668 N91-23194

HYPERSONIC FLOW
Entropy effects of hypersonic flow past blunt delta wings p 615 A91-37181
Computational analysis of underexpanded jets in the hypersonic regime p 615 A91-37421
Numerical study of hypersonic dissociated air past blunt bodies p 616 A91-37835
Stream functions for the hypersonic flow around quasi-pointed slender bodies at low angles of attack p 621 A91-39832
On the instability of hypersonic flow past a wedge p 621 A91-39922
Reacting shock waves in hypersonic propulsion applications p 629 N91-23174
Hypersonic aerodynamics fellowships
[AD-A233584] p 632 N91-24116

HYPERSONIC INLETS
Supersonic-hypersonic inlet studies for aerospaceplane p 659 N91-23160
The 3-D Navier-Stokes analysis of crossing, glancing shocks/turbulent boundary layer interactions
[NASA-TM-104469] p 633 N91-24130

HYPERSONIC SPEED
On the Goertler vortex instability mechanism at hypersonic speeds p 623 A91-39940
Hypersonic Combined Cycle Propulsion
[AGARD-CP-479] p 657 N91-23147
Hypersonic propulsion: Past and present p 657 N91-23148

HYPERSONIC VEHICLES
Effect of exhaust plume/afterbody interaction on installed scramjet performance p 615 A91-37770
Titanium aluminides for aerospace applications p 671 A91-39302
Performance characteristics of hypersonic detonation wave ramjets p 659 N91-23168

HYPERSONIC WAKES
The stability to two-dimensional wakes and shear layers at high Mach numbers p 614 A91-36452

HYPERSONIC WIND TUNNELS
IAI hypersonic wind tunnel
[IAITIC-87-1006] p 668 N91-23194

HYPERSONICS
Aerodynamic preliminary analysis system 2. Part 1: Theory
[NASA-CR-182076] p 626 N91-23080
Aerodynamic preliminary analysis system 2. Part 2: User's manual
[NASA-CR-182077] p 627 N91-23081
Performance characteristics of hypersonic detonation wave ramjets p 659 N91-23168
Hypersonic aerodynamics fellowships
[AD-A233584] p 632 N91-24116

HYPERVELOCITY FLOW
Advanced Hypervelocity Aerophysics Facility Workshop
[NASA-CP-10031] p 669 N91-24211

HYPOBARIC ATMOSPHERES
A test of the American Safety Flight Systems, Inc. prebreather/portable oxygen system
[AD-A232723] p 636 N91-23100

HYSTERESIS
Static measurements of slender delta wing rolling moment hysteresis p 625 A91-40223

I

ICE
Simulation of iced wing aerodynamics
[NASA-TM-104362] p 628 N91-23086
Icing simulation: A survey of computer models and experimental facilities
[NASA-TM-104366] p 628 N91-23087
Advanced ice protection systems test in the NASA Lewis icing research tunnel
[NASA-TM-103757] p 661 N91-23183
Model rotor icing tests in the NASA Lewis icing research tunnel
[NASA-TM-104351] p 661 N91-23184

ICE FORMATION
The LWC parameter - Some experimental results --- liquid water content in atmosphere p 685 A91-38388
Water droplet impingement on airfoils and aircraft engine inlets for icing analysis p 634 A91-38543
Effects of horizontal tail ice on longitudinal aerodynamic derivatives p 665 A91-38547
Simulation of iced wing aerodynamics
[NASA-TM-104362] p 628 N91-23086
Icing simulation: A survey of computer models and experimental facilities
[NASA-TM-104366] p 628 N91-23087
Advanced ice protection systems test in the NASA Lewis icing research tunnel
[NASA-TM-103757] p 661 N91-23183
Model rotor icing tests in the NASA Lewis icing research tunnel
[NASA-TM-104351] p 661 N91-23184

ICE PREVENTION
Icing simulation: A survey of computer models and experimental facilities
[NASA-TM-104366] p 628 N91-23087
Advanced ice protection systems test in the NASA Lewis icing research tunnel
[NASA-TM-103757] p 661 N91-23183

ILLUMINANCE
Radioluminescent (RL) lighting system development program
[DE91-009743] p 679 N91-23381

IMAGE RESOLUTION
Relative effectiveness of 2-D vs. 1-D high resolution microwave imageing p 641 A91-37094

IMAGING RADAR
Radiation transmission in adverse weather p 675 A91-37880
Clutter modeling of the Denver Airport and surrounding areas p 638 N91-24152

IMPINGEMENT
Interferometric investigation of supersonic flow fields with shock-shock interactions p 627 N91-23082

IN-FLIGHT MONITORING
Aircraft Command in Emergency Situations (ACES). Phase 1: Concept development
[DOT/FAA/CT-90/21] p 636 N91-23097
Mechanical component diagnostic system
[AD-A232126] p 656 N91-23146
The electrical flight control system of A320 Airbus: A fault tolerant system
[REPT-911-111-103] p 667 N91-23192

INCOMPRESSIBLE FLOW
Quantitative analysis of flow visualizations in ONERA water tunnels p 677 A91-39694
Experimental and theoretical analysis of natural transition on 'infinite' swept wing p 621 A91-39927
Modeling for unsteady aerodynamics of rectangular wing in incompressible flow using step responses p 625 A91-40473

INERTIAL NAVIGATION
Status of turbulence Prediction System's AWAS 3 p 637 N91-24146

INFLATABLE STRUCTURES
An update on SKAD (survival kit air droppable) systems p 635 A91-39384

INFORMATION DISSEMINATION
Kansas Aviation Review
[NIAR-91-3] p 613 N91-24087

INFORMATION MANAGEMENT
An overview of information resources in aviation p 690 N91-24091

INFRARED DETECTORS
Fire detection system for aircraft cargo bays p 655 A91-36755
Model for IR sensor performance evaluation - Applications and results p 656 A91-39890
Status of NASA's IR wind shear detection research p 637 N91-24145
Integrated data analysis of July 7, 1990 microburst p 685 N91-24170

INFRARED IMAGERY
Airfoil transition and separation studies using an infrared imaging system p 624 A91-40215

INFRARED INSTRUMENTS
Status of turbulence Prediction System's AWAS 3 p 637 N91-24146
INFRARED RADAR
CLASS: Coherent Lidar Airborne Shear Sensor. Windshear avoidance
[LMSC-F-415048] p 636 N91-24141
INFRARED RADIOMETERS
An airborne FLIR detection and warning system for low altitude wind shear p 637 N91-24147
INGESTION (ENGINES)
Suckdown, fountain lift, and pressures induced on several tandem jet V/STOL configurations
[NASA-TM-102817] p 630 N91-24108
INJECTION MOLDING
Fabrication of engineering ceramics by injection molding p 674 A91-37375
Improved silicon carbide for advanced heat engines
[NASA-CR-182289] p 672 N91-24451
INJECTORS
Subsonic and supersonic combustion using noncircular injectors p 674 A91-37414
INJURIES
The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the copilot/gunner, volume 2
[AD-A232907] p 641 N91-24187
The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the copilot/gunner, volume 1
[AD-A233349] p 641 N91-24188
INLET FLOW
Hot gas ingestion test results of a two-poster vectored thrust concept with flow visualization in the NASA Lewis 9- by 15-foot low speed wind tunnel
[AIAA PAPER 90-2268] p 626 A91-40561
A study of three dimensional turbulent boundary layer separation and vortex flow control using the reduced Navier Stokes equations
[NASA-TM-104407] p 628 N91-23089
Some aspects of shock-wave boundary layer interaction relevant to intake flows p 628 N91-23161
Effects of inlet distortion on the development of secondary flows in a subsonic axial inlet compressor rotor
[NASA-TM-104356] p 660 N91-23179
Computation of inlet reference plane flow-field for a subscale free-jet forebody/inlet model and comparison to experimental data
[AD-A232101] p 680 N91-23445
INSPECTION
Kansas Aviation Review
[NIAR-91-3] p 613 N91-24087
Evaluation of automation for inspection of aging aircraft p 613 N91-24088
INSTRUMENT LANDING SYSTEMS
Microwave landing system modeling with application to air traffic control
[NASA-TM-102832] p 636 N91-23099
LIDAR studies on microbursts p 639 N91-24167
INSTRUMENT PACKAGES
An engineering study of altitude determination deficiencies of the Service Aircraft Instrumentation Package (SAIP)
[AD-A232055] p 656 N91-23145
INTEGRALS
Application of path-independent integrals to elevated temperature crack growth p 671 A91-38819
INTERACTIONAL AERODYNAMICS
Discontinuous solutions for a three-dimensional hypersonic boundary layer with interaction p 614 A91-37176
Interactive three-dimensional boundary-layer method for transonic flow over swept wings p 616 A91-37829
Tip vortex/airfoil interaction for a low Reynolds number canard/wing configuration p 617 A91-38545
Second mode interactions in supersonic boundary layers p 623 A91-39957
Calculation of low Reynolds number flows at high angles of attack p 624 A91-40218
Analysis of circular elastic membrane wings p 625 A91-40472
Buffet induced structural/flight-control system interaction of the X-29A aircraft
[NASA-TM-101735] p 652 N91-23133
Some aspects of shock-wave boundary layer interaction relevant to intake flows p 628 N91-23161
Aerodynamic interactions between bodies in relative motion p 629 N91-24103
INTERFERENCE LIFT
Suckdown, fountain lift, and pressures induced on several tandem jet V/STOL configurations
[NASA-TM-102817] p 630 N91-24108
INTERFEROMETERS
Interferometric investigation of supersonic flow fields with shock-shock interactions p 627 N91-23082
INTERMETALLICS
Titanium aluminides for aerospace applications p 671 A91-39302
INTERNATIONAL COOPERATION
Accent on hypersonic p 669 A91-36625
INVESTMENTS
Aviation system capital investment plan
[PB91-150268] p 644 N91-24189
INVISCID FLOW
Computation of three-dimensional flow fields through compressor blade rows p 625 A91-40375
Fluid dynamics for the study of transonic flow --- Book p 625 A91-40513
Block implicit multigrid solution of the Euler equations p 680 N91-23413
The computation of induced drag with nonplanar and deformed wakes p 630 N91-24106
Implicit solvers for unstructured meshes
[NASA-CR-187564] p 633 N91-24125
Viscous design and analysis methods for transonic compressor blading
[AD-A232902] p 682 N91-24530
ISENTROPIC PROCESSES
An isentropic compression-heated Ludweig tube transient wind tunnel p 673 A91-36450
ITERATIVE SOLUTION
Application of multiple-input/single-output analysis procedures to flight test data p 647 A91-39420
Synchronous iterative method for computation of vortex flows at high angles of attack p 624 A91-40126
Navigation, guidance, and trajectory optimization for hypersonic vehicles p 644 N91-23150
Implicit solvers for unstructured meshes
[NASA-CR-187564] p 633 N91-24125

J

JAMMING
SATURN: The next generation radio for NATO p 682 N91-24475
JET AIRCRAFT
Handling qualities of highly augmented unstable aircraft summary of an AGARD-FMP working group effort p 666 N91-23116
Metrics for roll response flying qualities p 650 N91-23118
JET AIRCRAFT NOISE
A study on sonic load of the vertical tail of F-7 aircraft p 648 A91-40171
JET ENGINE FUELS
Fuel-rich, catalytic reaction experimental results
[NASA-TM-104423] p 662 N91-24203
Advanced thermally stable jet fuels development program annual report. Volume 3: Fuel lubricity
[AD-A232793] p 673 N91-24453
JET ENGINES
Sensor failure detection for jet engines p 656 A91-37593
A general method for rotordynamic analysis p 677 A91-39585
NKK premium quality titanium master alloy p 672 A91-40425
JET EXHAUST
Computation of axisymmetric slender bodies enclosing a jet efflux in pitching oscillatory motion p 618 A91-38681
JET FLOW
Computational analysis of underexpanded jets in the hypersonic regime p 615 A91-37421
Experiments on the unsteadiness associated with a ground vortex p 624 A91-40220
JET IMPINGEMENT
Numerical study of twin-jet impingement upwash flow p 619 A91-38736
Experiments on the unsteadiness associated with a ground vortex p 624 A91-40220
JET MIXING FLOW
A CFD study of jet mixing in reduced flow areas for lower combustor emissions
[NASA-TM-104411] p 661 N91-23185
Mixing of multiple jets with a confined subsonic crossflow. Summary of NASA-supported experiments and modeling
[NASA-TM-104412] p 662 N91-24202
JETTISON SYSTEMS
Demonstration of a Laser Ordnance Initiation System in an F-16 sled --- for flight crew escape system p 646 A91-39377
Helicopter in-flight stores jettison p 671 A91-39389
Canopy breaking system for non-delay pilot rescue p 647 A91-39398
JP-8 JET FUEL
Advanced thermally stable jet fuels development program annual report. Volume 3: Fuel lubricity
[AD-A232793] p 673 N91-24453

K

K-EPSILON TURBULENCE MODEL
Numerical investigation of airfoil/jet/fuselage-undersurface flowfields in ground effect p 617 A91-38541
KALMAN FILTERS
Track initiation using MHT in dense environments --- Multiple Hypotesis Tracking p 674 A91-37141
Angle-only tracking filter in modified spherical coordinates p 643 A91-39433
KEROSENE
Detection of traces of water in aviation kerosenes by gas chromatography p 670 A91-37182

L

LABYRINTH SEALS
Vibration behavior of a labyrinth seal with through-flow p 679 A91-40241
LAMINAR BOUNDARY LAYER
A model for the experimental study of curvature effects on transition of the boundary layer on a swept wing - Preliminary results p 620 A91-39691
Transition research in low-disturbance high-speed wind tunnels p 621 A91-39919
On the stability of swept wing laminar boundary layers including curvature effects p 622 A91-39933
Passive laminar flow control of crossflow vorticity
[NASA-CASE-LAR-13563-1] p 679 N91-23410
The NASA Langley laminar-flow-control experiment on a swept, supercritical airfoil: Suction coefficient analysis
[NASA-TM-4267] p 629 N91-24098
Laminar-flow wind tunnel experiments p 634 N91-24136
Results of correlations for transition location on a clean-up glove installed on an F-14 aircraft and design studies for a laminar glove for the X-29 aircraft accounting for spanwise pressure gradient p 654 N91-24138
Variable Sweep Transition Flight Experiment (VSTFE): Unified Stability System (USS). Description and users' manual
[NASA-CR-181918] p 634 N91-24139
The 1989 high-speed civil transport studies
[NASA-CR-4375] p 654 N91-24195
The effects on aerodynamic performance of designing supersonic wings for laminar flow control
[AD-A233040] p 654 N91-24197
Evaluation of cloud detection instruments and performance of laminar-flow leading-edge test articles during NASA Leading-Edge Flight-Test Program
[NASA-TP-2888] p 655 N91-24199
LAMINAR FLOW
The stability to two-dimensional wakes and shear layers at high Mach numbers p 614 A91-36452
Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Ecole Nationale Superieure de l'Aeronautique et de l'Espace, Toulouse, France, Sept. 11-15, 1989 p 677 A91-39901
On the development of turbulent spots in plane Poiseuille flow p 678 A91-39904
Boundary layer control by a local heating of the wall p 678 A91-39909
Investigations on flow instabilities on airfoils by means of piezofoil-arrays p 621 A91-39911
The effect of isolated roughness elements on transition in attachment-line flows p 678 A91-39959
A computationally efficient modelling of laminar separation bubbles p 680 N91-23411
Laminar-flow flight experiments p 634 N91-24135
Laminar-flow wind tunnel experiments p 634 N91-24136
Effects of wing sweep on in-flight boundary-layer transition for a laminar flow wing at Mach numbers from 0.60 to 0.79
[NASA-TM-101701] p 683 N91-24555
Effects of wing sweep on boundary-layer transition for a smooth F-14A wing at Mach numbers from 0.700 to 0.825
[NASA-TM-101712] p 683 N91-24556
LAMINAR FLOW AIRFOILS
Forward sweep - A favorable concept for a laminar flow wing p 615 A91-37767
LANDING AIDS
Functional-adaptive data processing in airborne radio navigation and landing systems p 643 A91-39187
Along for the ride? --- computer-automated aviation overview p 656 A91-40550

LANDING GEAR
A numerical method for simulating drop test of landing gears p 648 A91-40174
Landing gear drop testing p 648 A91-40203
Long time measurements of landing gear loads on SAAB SF-340 commuter aircraft
[FFA-TN-1990-53] p 653 N91-23138
LANDING LOADS
Long time measurements of landing gear loads on SAAB SF-340 commuter aircraft
[FFA-TN-1990-53] p 653 N91-23138
LAPSE RATE
Temperature lapse rate as an adjunct to wind shear detection p 640 N91-24184
LASER APPLICATIONS
Demonstration of a Laser Ordnance Initiation System in an F-16 sled --- for flight crew escape system p 646 A91-39377
Hot gas ingestion test results of a two-poster vectored thrust concept with flow visualization in the NASA Lewis 9- by 15-foot low speed wind tunnel
[AIAA PAPER 90-2268] p 626 A91-40561
LATERAL CONTROL
Metrics for roll response flying qualities p 650 N91-23118
LAUNCH VEHICLE CONFIGURATIONS
Airbreathing propulsion for transatmospheric flight p 659 N91-23156
LEADING EDGE SWEEP
The performance of 60 deg delta wings: The effects of leading edge radius on vortex flaps and the wing
[CRANFIELD-AERO-9004] p 628 N91-23092
The performance of 60 deg delta wings: The effects of leading edge radius and vortex flaps
[CRANFIELD-AERO-9002] p 653 N91-23140
Unsteady Navier-Stokes solutions for a low aspect ratio delta wing
[AD-A233201] p 631 N91-24112
LEADING EDGES
Boundary layer tripping in supersonic flow p 623 A91-39960
Simulation of iced wing aerodynamics
[NASA-TM-104362] p 628 N91-23086
Unsteady flow structure from swept edges subjected to controlled motion
[AD-A232714] p 628 N91-23094
Oxidation resistant carbon/carbon materials
[REPT-911-430-105] p 672 N91-23251
Simulation of brush insert for leading-edge-passage convective heat transfer
[NASA-TM-103801] p 679 N91-23409
Breaking down the delta wing vortex: The role of vorticity in the breakdown process
[NASA-CR-188235] p 630 N91-24109
An experimental analysis of critical factors involved in the breakdown process of leading edge vortex flows
[NASA-CR-188231] p 631 N91-24110
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 2: User manual for VORSTAB-2
[AD-A233483] p 631 N91-24114
Evaluation of cloud detection instruments and performance of laminar-flow leading-edge test articles during NASA Leading-Edge Flight-Test Program
[NASA-TP-2888] p 655 N91-24199
LIFE (DURABILITY)
Application of cyclic damage accumulation life prediction model to high temperature components p 681 N91-24309
Notched fatigue of single crystal PWA 1480 at turbine attachment temperatures p 682 N91-24310
LIFE RAFTS
An update on SKAD (survival kit air droppable) systems p 635 A91-39384
LIFT
On the improvement of the supersonic lifting line theory p 614 A91-36695
Wing calculation in supersonic flow by means of the supersonic lifting line theory p 614 A91-36700
Aerodynamic calculation of tandem wings in supersonic flow by means of SLLT p 614 A91-36724
Blunt-nosed swept supercritical LFC wings without nose flaps p 622 A91-39936
Status of heavy rain tests p 640 N91-24180
LIFT DRAG RATIO
Analytical studies on static aeroelastic behavior of forward-swept composite wing structures p 674 A91-37774
Aerodynamic characteristics of scissor-wing geometries p 624 A91-40216
Aerodynamic characteristics of crescent and elliptic wings at high angles of attack p 624 A91-40219
The performance of 60 deg delta wings: The effects of leading edge radius on vortex flaps and the wing
[CRANFIELD-AERO-9004] p 628 N91-23092
The performance of 60 deg delta wings: The effects of leading edge radius and vortex flaps
[CRANFIELD-AERO-9002] p 653 N91-23140
LIFTING BODIES
Unsteady, frequency-domain analysis of helicopter non-rotating lifting surfaces p 613 A91-36359
Analysis of numerical solutions for three-dimensional lifting wing flows p 625 A91-40498
LIGHT HELICOPTERS
Analytical study of the effects of weight on Light Helicopter (LH) exposure to ground-based weapons
[AD-A232024] p 653 N91-23141
LIGHT TRANSMISSION
Radiation transmission in adverse weather p 675 A91-37880
LIGHTING EQUIPMENT
Radioluminescent (RL) lighting system development program
[DE91-009743] p 679 N91-23381
LIGHTNING
Lightning protection requirements for aircraft: A proposed specification
[RAE-TM-FS(F)-632-ISSUE-1-R] p 641 N91-24186
LIGHTNING SUPPRESSION
Lightning protection requirements for aircraft: A proposed specification
[RAE-TM-FS(F)-632-ISSUE-1-R] p 641 N91-24186
LINE OF SIGHT
Angle-only tracking filter in modified spherical coordinates p 643 A91-39433
LINEAR SYSTEMS
Robust eigenstructure assignment with structured state space uncertainty p 686 A91-39417
LININGS
An experimental evaluation of combustor liner materials for solid fuel ramjet testing p 670 N91-24289
LIQUID AIR CYCLE ENGINES
Comparative study of different systems of combined cycle propulsion p 658 N91-23152
LIQUID COOLING
Water-cooling technique of high temperature gas turbine blade
[DE91-764238] p 681 N91-23506
LIQUID CRYSTALS
Visualisation of boundary layer transition p 623 A91-39964
LIQUID HYDROGEN
Simulation of brush insert for leading-edge-passage convective heat transfer
[NASA-TM-103801] p 679 N91-23409
LOAD DISTRIBUTION (FORCES)
A study on sonic load of the vertical tail of F-7 aircraft p 648 A91-40171
LOAD TESTS
Computerized system for static and fatigue large scale structural tests: A case study
[IAITIC-87-1007] p 681 N91-23522
Improved silicon carbide for advanced heat engines
[NASA-CR-182289] p 672 N91-24451
LONG DURATION EXPOSURE FACILITY
Surface activation of Concorde by Be-7 p 690 N91-24983
LONGITUDINAL CONTROL
Handling qualities guidelines for the design of fly-by-wire flight control systems for transport aircraft p 667 N91-23119
LONGITUDINAL STABILITY
The influence of altitude and speed variations over the aircraft flight control response during the longitudinal nonlinear manoeuvres p 664 A91-36722
LOW ALTITUDE
Air ambulance helicopter operational analysis
[DOT/FAA/RD-91/7] p 652 N91-23134
An airborne FLIR detection and warning system for low altitude wind shear p 637 N91-24147
LOW ASPECT RATIO WINGS
Unsteady Navier-Stokes solutions for a low aspect ratio delta wing
[AD-A233201] p 631 N91-24112
LOW COST
Fighter escape system - The next step forward p 646 A91-39382
LOW REYNOLDS NUMBER
Tip vortex/airfoil interaction for a low Reynolds number canard/wing configuration p 617 A91-38545
Calculation of low Reynolds number flows at high angles of attack p 624 A91-40218
LOW SPEED
Effects of canard position on the aerodynamic characteristics of a close-coupled canard configuration at low speed p 649 A91-40495
LOW SPEED STABILITY
Analysis and control of low-speed forced unsteady flow p 676 A91-38697
LOW SPEED WIND TUNNELS
The performance of 60 deg delta wings: The effects of leading edge radius on vortex flaps and the wing
[CRANFIELD-AERO-9004] p 628 N91-23092
The performance of 60 deg delta wings: The effects of leading edge radius and vortex flaps
[CRANFIELD-AERO-9002] p 653 N91-23140
LOW THRUST PROPULSION
Turbojet potential for hypersonic flight p 658 N91-23155
LUBRICATION
Advanced thermally stable jet fuels development program annual report. Volume 3: Fuel lubricity
[AD-A232793] p 673 N91-24453
LUMINESCENCE
Radioluminescent (RL) lighting system development program
[DE91-009743] p 679 N91-23381

M

MACH NUMBER
Inception length to a fully developed, fin-generated, shock-wave, boundary-layer interaction p 617 A91-37842
Effects of wing sweep on in-flight boundary-layer transition for a laminar flow wing at Mach numbers from 0.60 to 0.79
[NASA-TM-101701] p 683 N91-24555
Effects of wing sweep on boundary-layer transition for a smooth F-14A wing at Mach numbers from 0.700 to 0.825
[NASA-TM-101712] p 683 N91-24556
MAGNETIC TAPES
An overview of information resources in aviation p 690 N91-24091
MAINTENANCE
Bonded/fusion repair of aircraft structures p 613 N91-24160
MAN MACHINE SYSTEMS
Normalized predictive deconvolution - Multichannel time-series applications to human dynamics p 686 A91-37584
Methodology for the analytical assessment of aircraft handling qualities p 664 A91-37597
Identification of pilot-vehicle dynamics from simulation and flight test p 664 A91-37598
National remote computational flight research facility
[NASA-CR-179432] p 668 N91-24210
MANEUVERABILITY
Agility: A rational development of fundamental metrics and their relationship to flying qualities p 651 N91-23129
A review of high angle of attack requirements for combat aircraft p 651 N91-23130
X-31A at first flight p 651 N91-23131
MANUFACTURING
NKK premium quality titanium master alloy p 672 A91-40425
Estimating fixed and variable costs of airframe manufacturers
[AD-A232661] p 613 N91-23077
How to know CMC
[REPT-911-430-130] p 672 N91-23262
MASS FLOW RATE
Mach 4 testing of scramjet inlet models p 615 A91-37418
MATHEMATICAL MODELS
Airfoil design method using the Navier-Stokes equations p 646 A91-38550
Near midair collisions as an indicator of general aviation collision risk p 635 N91-23096
Application of multidisciplinary optimization methods to the design of a supersonic transport
[NASA-TM-104073] p 652 N91-23135
The limits of the landing process of aircraft
[DLR-FB-90-49] p 653 N91-23137
Design techniques for dual mode ram-scramjet combustors p 659 N91-23166
Evaluation techniques for highly augmented aircraft
[DLR-FB-90-35] p 667 N91-23191
A computationally efficient modelling of laminar separation bubbles p 680 N91-23411
Modal analysis of multistage gear systems coupled with gearbox vibrations
[NASA-TM-103797] p 681 N91-23513
Model sensitivity in stress-strength reliability computations
[AD-A232023] p 681 N91-23554
An initial investigation into methods of computing transonic aerodynamic sensitivity coefficients
[NASA-CR-188192] p 629 N91-24099
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 1: Steady
[AD-A233482] p 631 N91-24113

NASA Langley flight test program p 639 N91-24175
MLS mathematical model validation study using airborne MLS data from Atlantic City International Airport Boeing 727 elevation shadowing flight tests
[DOT-FAA/CT-TN90/55] p 644 N91-24190
A system approach to aircraft optimization
[NASA-TM-104074] p 654 N91-24196
Advanced computational models for analyzing high speed propulsive flowfields p 686 N91-24291
Notched fatigue of single crystal PWA 1480 at turbine attachment temperatures p 682 N91-24310
Evaluation of the qualification of the structure of a passenger aircraft by analysis and full-scale testing p 684 N91-24645
The role of structural analysis in airworthiness certification p 684 N91-24647
Influence of the refinement of structural calculation on aircraft qualification procedures p 684 N91-24649

MECHANICAL PROPERTIES
Titanium aluminides for aerospace applications p 671 A91-39302

MEDICAL SCIENCE
A test of the American Safety Flight Systems, Inc. prebreather/portable oxygen system
[AD-A232723] p 636 N91-23100

MENTAL PERFORMANCE
Kansas Aviation Review
[NIAR-91-3] p 613 N91-24087

METAL FATIGUE
Fatigue crack growth in monolithic titanium aluminides p 670 A91-38809

METAL MATRIX COMPOSITES
Metal matrix composite vertical tail fabrication
[SME PAPER EM90-438] p 611 A91-36875

METEOROLOGICAL PARAMETERS
Air ambulance helicopter operational analysis
[DOT/FAA/RD-91/7] p 652 N91-23134
Temperature lapse rate as an adjunct to wind shear detection p 640 N91-24184

METEOROLOGICAL RADAR
Clutter rejection in Doppler weather radars used for airport wind shear detection p 685 A91-37104
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 2
[NASA-CP-10060-PT-2] p 636 N91-24140
Continuous wave laser for wind shear detection p 637 N91-24142
Status of turbulence Prediction System's AWAS 3 p 637 N91-24146
Wind Shear radar program future plans p 637 N91-24151
Clutter modeling of the Denver Airport and surrounding areas p 638 N91-24152
RADAR performance experiments p 639 N91-24168
Integrated data analysis of July 7, 1990 microburst p 685 N91-24170
Microburst avoidance simulation tests p 639 N91-24172
Orlando experiment p 640 N91-24177
Integration of the TDWR and LLWAS wind shear detection system p 640 N91-24178
Thermodynamic Alerter for Microbursts (TAMP) p 640 N91-24179

METEOROLOGY
Integration of weather sensing devices p 639 N91-24174

METHOD OF CHARACTERISTICS
The 2-D supersonic nozzle design p 660 N91-23176

METHYL ALCOHOL
Methanol - An environmentally attractive alternative commercial aviation fuel p 670 A91-38129

MICROBURSTS (METEOROLOGY)
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 2
[NASA-CP-10060-PT-2] p 636 N91-24140
CLASS: Coherent Lidar Airborne Shear Sensor. Windshear avoidance
[LMSC-F-415048] p 636 N91-24141
An airborne FLIR detection and warning system for low altitude wind shear p 637 N91-24147
Saberliner flight test for airborne wind shear forward looking detection and avoidance radar systems p 637 N91-24149
Radar simulation program upgrade and algorithm development p 638 N91-24153
Signal processing techniques for clutter filtering and wind shear detection p 638 N91-24154
Airborne radar simulation studies of the Denver July 11, 1988 microburst p 638 N91-24155
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 1
[NASA-CP-10060-PT-1] p 639 N91-24166
LIDAR studies on microbursts p 639 N91-24167
Integrated data analysis of July 7, 1990 microburst p 685 N91-24170
Microburst avoidance simulation tests p 639 N91-24172
Wind shear training applications for 91/135 p 639 N91-24173
TDWR information on the flight deck p 640 N91-24176
Orlando experiment p 640 N91-24177
Integration of the TDWR and LLWAS wind shear detection system p 640 N91-24178
Thermodynamic Alerter for Microbursts (TAMP) p 640 N91-24179
Estimate of heavy rain performance effect p 640 N91-24182
Temperature lapse rate as an adjunct to wind shear detection p 640 N91-24184

MICROFILMS
An overview of information resources in aviation p 690 N91-24091

MICROWAVE IMAGERY
Relative effectiveness of 2-D vs. 1-D high resolution microwave imageing p 641 A91-37094

MICROWAVE LANDING SYSTEMS
Air traffic control today and tomorrow p 642 A91-38215
Microwave landing system modeling with application to air traffic control
[NASA-TM-102832] p 636 N91-23099
MLS mathematical model validation study using airborne MLS data from Atlantic City International Airport Boeing 727 elevation shadowing flight tests
[DOT-FAA/CT-TN90/55] p 644 N91-24190

MICROWAVE TRANSMISSION
Radiation transmission in adverse weather p 675 A91-37880
406 MHz ELT signal spectra for Sarsat p 643 A91-39778

MIDAIR COLLISIONS
Near midair collisions as an indicator of general aviation collision risk p 635 N91-23096

MILITARY AIRCRAFT
Development and demonstration of CREST subsystems --- computer program for ejection seats p 646 A91-39380
The Minipac II ejection seat program p 647 A91-39390
The costs and benefits of aircraft availability
[AD-A232660] p 613 N91-23076
Flying Qualities
[AGARD-CP-508] p 649 N91-23108
MIL-STD-1797 is not a cookbook p 650 N91-23111
Flying qualities experience on the AMX aircraft p 650 N91-23112
The development of alternate criteria for FBW handling qualities p 666 N91-23113
Do civil flying qualities requirements address military missions for off-the-shelf procurement p 650 N91-23115
Analytical study of the effects of weight on Light Helicopter (LH) exposure to ground-based weapons
[AD-A232024] p 653 N91-23141
An engineering study of altitude determination deficiencies of the Service Aircraft Instrumentation Package (SAIP)
[AD-A232055] p 656 N91-23145
Some analysis of decision-making in the test manufacture of military aircraft
[AD-A233111] p 613 N91-24093

MILITARY HELICOPTERS
One-on-one helicopter combat simulated by chess-type lookahead p 668 A91-37775
Helicopter in-flight stores jettison p 671 A91-39389
Comanche - Tomorrow's high-tech helicopter p 649 A91-40254
ADFCS and NOTAR (trademark): Two ways to fix flying qualities p 650 N91-23110
The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the copilot/gunner, volume 2
[AD-A232907] p 641 N91-24187

MIMO (CONTROL SYSTEMS)
Control law synthesis and stability robustness improvement using constrained optimization techniques p 686 A91-37591
Application of multiple-input/single-output analysis procedures to flight test data p 647 A91-39420

MISSILE CONFIGURATIONS
Small Engine Component Technology (SECT) studies
[NASA-CR-175080] p 663 N91-24206

MISSILES
Air surveying and data analysis for dynamic response of missiles at swept-back wing tip p 647 A91-40156

MODAL RESPONSE
Modal analysis for fibre-carbon composite parts of an airplane p 679 A91-40157
Application of identification method of modal parameters to flight flutter test p 665 A91-40167

MODEL REFERENCE ADAPTIVE CONTROL
Decoupled flight control via a model-following technique using the Euler operator p 664 A91-37595

MOISTURE CONTENT
Detection of traces of water in aviation kerosenes by gas chromatography p 670 A91-37182

MONITORS
Precision runway monitor demonstration report
[AD-A232671] p 669 N91-23198

MONTE CARLO METHOD
The limits of the landing process of aircraft
[DLR-FB-90-49] p 653 N91-23137

MOVING TARGET INDICATORS
Measurement of clutter suppression using a Quadrahedral p 674 A91-37106
All solid-state ASR with adaptive pulse Doppler processing p 641 A91-37107

MRCA AIRCRAFT
Fighter escape system - The next step forward p 646 A91-39382

MULTIGRID METHODS
Cell centered and cell vertex multigrid schemes for the Navier-Stokes equations p 674 A91-37834
Block multigrid implicit solution of the Euler equations of compressible fluid flow p 616 A91-37836
A general multiblock Euler code for propulsion integration. Volume 1: Theory document
[NASA-CR-187484-VOL-1] p 632 N91-24120
A general multiblock Euler code for propulsion integration. Volume 2: User guide for BCON, pre-processor for grid generation and GMBE
[NASA-CR-187484-VOL-2] p 632 N91-24121
A general multiblock Euler code for propulsion integration. Volume 3: User guide for the Euler code
[NASA-CR-187484-VOL-3] p 632 N91-24122

MULTIPATH TRANSMISSION
Microwave landing system modeling with application to air traffic control
[NASA-TM-102832] p 636 N91-23099

N

NACELLES
Identification of nacelle modes from airplane GVT results p 648 A91-40170

NASA SPACE PROGRAMS
The role of organizations in professional development p 690 A91-38367

NASTRAN
Modal analysis of multistage gear systems coupled with gearbox vibrations
[NASA-TM-103797] p 681 N91-23513

NATIONAL AEROSPACE PLANE PROGRAM
Hypersonic propulsion: Status and challenge p 658 N91-23153

NATIONAL AIRSPACE SYSTEM
National airspace system. Communications operational concept NAS-SR-136
[DOT/FAA/SE-91/1] p 640 N91-24185
Aviation system capital investment plan
[PB91-150268] p 644 N91-24189

NAVIER-STOKES EQUATION
Three-dimensional finite element method analysis of turbulent flow over self-propelled slender bodies p 615 A91-37419
Cell centered and cell vertex multigrid schemes for the Navier-Stokes equations p 674 A91-37834
Airfoil design method using the Navier-Stokes equations p 646 A91-38550
Secondary frequencies in the wake of a circular cylinder with vortex shedding p 620 A91-39736
Theoretical study of Goertler vortices - Linear stability approach p 623 A91-39950
Direct numerical study of crossflow instability p 678 A91-39956
Second mode interactions in supersonic boundary layers p 623 A91-39957
A study of three dimensional turbulent boundary layer separation and vortex flow control using the reduced Navier Stokes equations
[NASA-TM-104407] p 628 N91-23089
Viscous three-dimensional analyses for nozzles for hypersonic propulsion p 629 N91-23175
Aero-thermal investigation of a highly loaded transonic linear turbine guide vane cascade. A test case for inviscid and viscous flow computations
[VKI-TN-174] p 680 N91-23437

Unsteady Navier-Stokes solutions for a low aspect ratio delta wing
[AD-A233201] p 631 N91-24112
The 3-D Navier-Stokes analysis of crossing, glancing shocks/turbulent boundary layer interactions
[NASA-TM-104469] p 633 N91-24130
A design strategy for the use of vortex generators to manage inlet-engine distortion using computational fluid dynamics
[NASA-TM-104436] p 633 N91-24131

NAVIGATION SATELLITES
Air traffic control today and tomorrow
p 642 A91-38215

NAVSTAR SATELLITES
Air traffic control today and tomorrow
p 642 A91-38215

NEAR WAKES
Vortex shedding and lock-on in bluff body wakes
p 675 A91-38689

NICKEL CADMIUM BATTERIES
Prismatic sealed Ni-Cd battery for aircraft power
p 657 A91-38178

NITROUS OXIDES
A CFD study of jet mixing in reduced flow areas for lower combustor emissions
[NASA-TM-104411] p 661 N91-23185

NOISE INTENSITY
AGARD flight test techniques series. Volume 9: Aircraft exterior noise measurement and analysis techniques
[AGARD-AG-300-VOL-9] p 689 N91-24843

NOISE MEASUREMENT
AGARD flight test techniques series. Volume 9: Aircraft exterior noise measurement and analysis techniques
[AGARD-AG-300-VOL-9] p 689 N91-24843

NOISE PREDICTION (AIRCRAFT)
Noise inside aircraft fuselages subjected to airborne excitations
[REPT-911-111-104] p 689 N91-23853

NOISE PROPAGATION
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 5: Propagation of propeller tone noise through a fuselage boundary layer
[NASA-CR-185195] p 689 N91-23852

NOISE REDUCTION
Clutter rejection in Doppler weather radars used for airport wind shear detection p 685 A91-37104
Full-scale demonstration tests of cabin noise reduction using active vibration control p 646 A91-38549
Application of acoustically treated honeycomb sandwich panels in noise control of aircraft cabin
p 648 A91-40160
Modification meets Chapter 3 standards --- re-engined Boeing 727 p 612 A91-40181
Noise inside aircraft fuselages subjected to airborne excitations
[REPT-911-111-104] p 689 N91-23853
Laboratory test and acoustic analysis of cabin treatment for propfan test assessment aircraft
[NASA-CR-182075] p 690 N91-24844

NONDESTRUCTIVE TESTS
How to know CMC
[REPT-911-430-130] p 672 N91-23262
Quantitative nondestructive evaluation: Requirements for tomorrow's reliability p 681 N91-24074

NONEQUILIBRIUM FLOW
Numerical study of hypersonic dissociated air past blunt bodies p 616 A91-37835

NONLINEARITY
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 1: Steady
[AD-A233482] p 631 N91-24113
Nonlinear analysis of composite shear webs with holes and correlation with tests p 684 N91-24642

NOSE CONES
Oxidation resistant carbon/carbon materials
[REPT-911-430-105] p 672 N91-23251

NOSE WHEELS
Long time measurements of landing gear loads on SAAB SF-340 commuter aircraft
[FFA-TN-1990-53] p 653 N91-23138

NOSES (FOREBODIES)
Blunt-nosed swept supercritical LFC wings without nose flaps p 622 A91-39936

NOTCH TESTS
Actual stresses in notches - How applicable are the common stress concentration factors?
p 676 A91-38775
Notched fatigue of single crystal PWA 1480 at turbine attachment temperatures p 682 N91-24310

NOZZLE DESIGN
The 2-D supersonic nozzle design
p 660 N91-23176
Development of a quiet supersonic wind tunnel with a cryogenic adaptive nozzle
[NASA-CR-186769] p 669 N91-23195

NOZZLE FLOW
Hot gas ingestion test results of a two-poster vectored thrust concept with flow visualization in the NASA Lewis 9- by 15-foot low speed wind tunnel
[AIAA PAPER 90-2268] p 626 A91-40561
Hypersonic Combined Cycle Propulsion
[AGARD-CP-479] p 657 N91-23147
Viscous three-dimensional analyses for nozzles for hypersonic propulsion p 629 N91-23175

NOZZLE GEOMETRY
Performance of an aerospace plane propulsion nozzle
p 615 A91-37769
The 2-D supersonic nozzle design
p 660 N91-23176

NUMERICAL ANALYSIS
Transonic analysis and design using an improved grid
p 624 A91-40137
A numerical method for simulating drop test of landing gears p 648 A91-40174
Unsteady Navier-Stokes solutions for a low aspect ratio delta wing
[AD-A233201] p 631 N91-24112

NUMERICAL CONTROL
Unsteady flow structure from swept edges subjected to controlled motion
[AD-A232714] p 628 N91-23094

NUMERICAL FLOW VISUALIZATION
Numerical simulation of steady and unsteady asymmetric vortical flow p 618 A91-38683
Visualization of the flow about a delta wing maneuvering in pitch to very high angle of attack p 618 A91-38684
Application of vortex dynamics to simulations of two-dimensional wakes p 676 A91-38706

O

OBLIQUE SHOCK WAVES
Interferometric investigation of supersonic flow fields with shock-shock interactions p 627 N91-23082
Analytical and experimental investigations of the oblique detonation wave engine concept p 660 N91-23169

OGIVES
Stream functions for the hypersonic flow around quasi-pointed slender bodies at low angles of attack
p 621 A91-39832

ONBOARD DATA PROCESSING
Mechanical component diagnostic system
[AD-A232126] p 656 N91-23146

OPTICAL MEASURING INSTRUMENTS
Velocity sensor for an airborne optical air data system
p 655 A91-38542

OPTICAL RADAR
Coherent lidar airborne windshear sensor - Performance evaluation p 655 A91-39873
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 2
[NASA-CP-10060-PT-2] p 636 N91-24140
CLASS: Coherent Lidar Airborne Shear Sensor. Windshear avoidance
[LMSC-F-415048] p 636 N91-24141
Continuous wave laser for wind shear detection
p 637 N91-24142
Status of 2 micron laser technology program
p 637 N91-24143
Avionic laser multisensor program at Litton Aero Products p 637 N91-24144
LIDAR studies on microbursts p 639 N91-24167

OPTICAL SCANNERS
Fire detection system for aircraft cargo bays
p 655 A91-36755

OPTIMAL CONTROL
Normalized predictive deconvolution - Multichannel time-series applications to human dynamics
p 686 A91-37584
Improvement of atmospheric flight performance of a space vehicle through sensitivity minimization
p 664 A91-37779

OPTIMIZATION
Control law synthesis and stability robustness improvement using constrained optimization techniques
p 686 A91-37591
Toward automating the design of centrifugal impellers
p 676 A91-38874
Sensitivity analysis, optimization, and data support in finite element systems p 677 A91-39230
Robust eigenstructure assignment with structured state space uncertainty p 686 A91-39417
Deployment optimization and human factors considerations for low-altitude troop parachutes
[AIAA PAPER 91-0889] p 635 A91-40559
Integrated multidisciplinary optimization of actively controlled fiber composite wings p 667 N91-23190
A system approach to aircraft optimization
[NASA-TM-104074] p 654 N91-24196

ORDNANCE
Demonstration of a Laser Ordnance Initiation System in an F-16 sled --- for flight crew escape system
p 646 A91-39377

ORGANIZATIONS
The role of organizations in professional development
p 690 A91-38367

ORR-SOMMERFELD EQUATIONS
An evaluation of stability-based methods for transition of three-dimensional flows p 678 A91-39928

OSCILLATING CYLINDERS
Computation of axisymmetric slender bodies enclosing a jet efflux in pitching oscillatory motion
p 618 A91-38681
Rotary oscillation control of a cylinder wake
p 620 A91-39708

OSCILLATING FLOW
Dynamic stall of an oscillating circulation control airfoil
p 617 A91-38677
Heat transfer in oscillating flows p 676 A91-38698

OXIDATION RESISTANCE
Oxidation resistant carbon/carbon materials
[REPT-911-430-105] p 672 N91-23251

OXYGEN PRODUCTION
Advanced airborne oxygen sensors
p 655 A91-39387

OXYGEN SUPPLY EQUIPMENT
A test of the American Safety Flight Systems, Inc. prebreather/portable oxygen system
[AD-A232723] p 636 N91-23100

P

P-51 AIRCRAFT
Moulded Mustang p 612 A91-39854

PAINTS
Automatic aircraft paint stripping
[SME PAPER MS90-280] p 611 A91-36895
Robotic sensors for aircraft paint stripping
[SME PAPER MS90-282] p 673 A91-36896
Mechanical paint removal techniques for composite aircraft p 613 N91-24163

PANEL FLUTTER
Supersonic flutter analysis of clamped symmetric composite panels using shear deformable finite elements p 675 A91-37847

PANEL METHOD (FLUID DYNAMICS)
Low-order panel method for internal flows
p 625 A91-40225
A vortex panel method for calculating aircraft downwash on parachute trajectories
[AIAA PAPER 91-0875] p 626 A91-40557
A vortex panel method for calculating aircraft downwash on parachute trajectories
[DE91-009764] p 627 N91-23085
The propagation of acoustic disturbances in the transonic flow fields of wings
[ESA-TT-1126] p 689 N91-23854
Theoretical evaluation of engine auxiliary inlet design for supersonic V/STOL aircraft
[NASA-CR-187098] p 633 N91-24123

PANELS
A new technique and application for nonlinear acoustic fatigue of stiffened composite panels
p 687 A91-38863
Application of acoustically treated honeycomb sandwich panels in noise control of aircraft cabin
p 648 A91-40160

PARACHUTE DESCENT
A vortex panel method for calculating aircraft downwash on parachute trajectories
[AIAA PAPER 91-0875] p 626 A91-40557
Low Altitude High Speed Cargo Parachute system development - A status report
[AIAA PAPER 91-0880] p 635 A91-40558
Deployment optimization and human factors considerations for low-altitude troop parachutes
[AIAA PAPER 91-0889] p 635 A91-40559

PARACHUTE FABRICS
An introduction to testing parachutes in wind tunnels
[AIAA PAPER 91-0858] p 668 A91-40556

PARACHUTES
An introduction to testing parachutes in wind tunnels
[AIAA PAPER 91-0858] p 668 A91-40556
Low Altitude High Speed Cargo Parachute system development - A status report
[AIAA PAPER 91-0880] p 635 A91-40558
Deployment optimization and human factors considerations for low-altitude troop parachutes
[AIAA PAPER 91-0889] p 635 A91-40559
A vortex panel method for calculating aircraft downwash on parachute trajectories
[DE91-009764] p 627 N91-23085

PARALLEL PROCESSING (COMPUTERS)
Enhancing aeropropulsion research with high-speed interactive computing
[NASA-TM-104374] p 687 N91-24796
PARAMETER IDENTIFICATION
Equation decoupling - A new approach to the aerodynamic identification of unstable aircraft
p 664 A91-37773
Application of identification method of modal parameters to flight flutter test p 665 A91-40167
Identification of nacelle modes from airplane GVT results p 648 A91-40170
PASSENGER AIRCRAFT
Commercial aircraft fuel efficiency potential through 2010 p 645 A91-38127
Evaluation of the qualification of the structure of a passenger aircraft by analysis and full-scale testing
p 684 N91-24645
PAVEMENTS
Literature review on geotextiles to improve pavements for general aviation airports
[AD-A232871] p 669 N91-23199
PAYLOADS
A dynamic analysis of the SRB parachute system
[AIAA PAPER 91-0838] p 670 A91-40555
PERFORMANCE PREDICTION
Aircraft electrical system computer simulation
p 657 A91-38037
Model for IR sensor performance evaluation - Applications and results p 656 A91-39890
The role of structural analysis in airworthiness certification p 684 N91-24647
PERFORMANCE TESTS
Evaluation of the qualification of the structure of a passenger aircraft by analysis and full-scale testing
p 684 N91-24645
PERTURBATION
Passive laminar flow control of crossflow vorticity
[NASA-CASE-LAR-13563-1] p 679 N91-23410
PHASE DEVIATION
Evaluation of the phase distortions of the input signal of a synthetic-aperture radar p 677 A91-39144
PHASED ARRAYS
High gain airborne antenna for satellite communications p 643 A91-39776
MEGASODAR experiment p 639 N91-24169
PILOT INDUCED OSCILLATION
The development of alternate criteria for FBW handling qualities p 666 N91-23113
Metrics for roll response flying qualities
p 650 N91-23118
PILOT PERFORMANCE
Evaluation techniques for highly augmented aircraft
[DLR-FB-90-35] p 667 N91-23191
PILOT TRAINING
Wind shear training applications for 91/135
p 639 N91-24173
PILOTLESS AIRCRAFT
Design and construction of a composite airframe for UAV research
[AD-A232422] p 653 N91-23143
PILOTS (PERSONNEL)
The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the copilot/gunner, volume 1
[AD-A233349] p 641 N91-24188
PIPES (TUBES)
Flexure vibration test method of aviation tube
p 648 A91-40172
PISTON ENGINES
Simulation of a combined-cycle engine
[NASA-CR-188232] p 683 N91-24583
PITCHING MOMENTS
Unsteady flow past an airfoil pitched at constant rate
p 617 A91-38679
Visualization of the flow about a delta wing maneuvering in pitch to very high angle of attack p 618 A91-38684
PLASTIC AIRCRAFT STRUCTURES
The design, manufacture, and test of a one-piece thermoplastic wing rib for tiltrotor aircraft
[SME PAPER EM90-665] p 645 A91-36940
Spot welded thermoplastic composite access door
[SME PAPER EM90-489] p 645 A91-36942
PLUMES
Computational analysis of underexpanded jets in the hypersonic regime p 615 A91-37421
PNEUMATICS
Advanced ice protection systems test in the NASA Lewis icing research tunnel
[NASA-TM-103757] p 661 N91-23183
POISSON DENSITY FUNCTIONS
The limits of the landing process of aircraft
[DLR-FB-90-49] p 653 N91-23137
PORTABLE EQUIPMENT
A field-deployable digital acoustic measurement system p 689 N91-24078
POTENTIAL FLOW
The breakdown of the linearized theory and the role of quadrupole sources in transonic rotor acoustics
p 688 A91-39749
The experimental investigation of stability and receptivity of a swept-wing flow p 623 A91-39944
Theoretical evaluation of engine auxiliary inlet design for supersonic V/STOL aircraft
[NASA-CR-187098] p 633 N91-24123
POTENTIAL THEORY
Aerodynamic preliminary analysis system 2. Part 1: Theory
[NASA-CR-182076] p 626 N91-23080
Aerodynamic preliminary analysis system 2. Part 2: User's manual
[NASA-CR-182077] p 627 N91-23081
POWERED LIFT AIRCRAFT
Static performance tests of a flight-type STOVL ejector
[NASA-TM-104437] p 662 N91-24201
PRANDTL-MEYER EXPANSION
The 2-D supersonic nozzle design
p 660 N91-23176
PREDICTION ANALYSIS TECHNIQUES
Prediction of test spectrum for gunfire vibration
p 666 A91-40175
Analytical and experimental investigations of the oblique detonation wave engine concept p 660 N91-23169
Results of correlations for transition location on a clean-up glove installed on an F-14 aircraft and design studies for a laminar glove for the X-29 aircraft accounting for spanwise pressure gradient p 654 N91-24138
Application of cyclic damage accumulation life prediction model to high temperature components
p 681 N91-24309
Notched fatigue of single crystal PWA 1480 at turbine attachment temperatures p 682 N91-24310
PREPREGS
Moulded Mustang p 612 A91-39854
PRESSURE DISTRIBUTION
Calculation of steady and unsteady pressures on wings at supersonic speeds with a transonic small-disturbance code p 617 A91-38544
Steady flow in a three-dimensional rectangular cavity yawed from the freestream turbulent boundary layer
p 619 A91-38742
Correlation of boundary layer stability analysis with flight transition data p 621 A91-39929
The effects on aerodynamic performance of designing supersonic wings for laminar flow control
[AD-A233040] p 654 N91-24197
Effects of wing sweep on in-flight boundary-layer transition for a laminar flow wing at Mach numbers from 0.60 to 0.79
[NASA-TM-101701] p 683 N91-24555
PRESSURE GRADIENTS
Dialogue on progress and issues in stability and transition research p 677 A91-39902
PRESSURE MEASUREMENT
An engineering study of altitude determination deficiencies of the Service Aircraft Instrumentation Package (SAIP)
[AD-A232055] p 656 N91-23145
PRESSURE OSCILLATIONS
Unsteady pressure fluctuation on a highly loaded turbine blade row p 619 A91-38702
PRESSURE SUITS
Northrop advanced fighter crew protection system. I - Engineering development. II - System development, test and evaluation p 647 A91-39395
PROBABILITY THEORY
Model sensitivity in stress-strength reliability computations
[AD-A232023] p 681 N91-23554
Probability approach for strength calculations
p 685 N91-24652
PROCEDURES
AGARD flight test techniques series. Volume 9: Aircraft exterior noise measurement and analysis techniques
[AGARD-AG-300-VOL-9] p 689 N91-24843
PROCESS CONTROL (INDUSTRY)
Automatic aircraft paint stripping
[SME PAPER MS90-280] p 611 A91-36895
CAPP imitative system of aircraft assembly --- Computer Aided Process Planning p 611 A91-37061
PROCUREMENT POLICY
Do civil flying qualities requirements address military missions for off-the-shelf procurement
p 650 N91-23115
PROGRAM VERIFICATION (COMPUTERS)
Water droplet impingement on airfoils and aircraft engine inlets for icing analysis p 634 A91-38543
Validation of in-house and external software systems at Aerospatiale p 687 N91-24640
Enhancing aeropropulsion research with high-speed interactive computing
[NASA-TM-104374] p 687 N91-24796
PROJECT PLANNING
Aviation system capital investment plan
[PB91-150268] p 644 N91-24189
PROP-FAN TECHNOLOGY
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 3: Application of theory for blade loading, wakes, noise, and wing shielding
[NASA-CR-185193] p 688 N91-23850
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 4: Computer user's manual for UAAP turboprop aeroacoustic code
[NASA-CR-185194] p 688 N91-23851
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 5: Propagation of propeller tone noise through a fuselage boundary layer
[NASA-CR-185195] p 689 N91-23852
Small Engine Component Technology (SECT) study
[NASA-CR-175079] p 663 N91-24208
PROPELLER FANS
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 4: Computer user's manual for UAAP turboprop aeroacoustic code
[NASA-CR-185194] p 688 N91-23851
PROPELLER NOISE
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 5: Propagation of propeller tone noise through a fuselage boundary layer
[NASA-CR-185195] p 689 N91-23852
PROPELLERS
An experimental study of an axisymmetric turbulent boundary layer disturbed by a periodic freestream
p 626 N91-23078
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 2: Development of theory for wing shielding
[NASA-CR-185192] p 688 N91-23849
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 5: Propagation of propeller tone noise through a fuselage boundary layer
[NASA-CR-185195] p 689 N91-23852
PROPULSION SYSTEM CONFIGURATIONS
NASA aeropropulsion research in support of propulsion systems of the 21st century
[NASA-TM-104403] p 627 N91-23083
Engine technology challenges for a 21st century high speed civil transport
[NASA-TM-104363] p 636 N91-23098
Airbreathing propulsion for space transport: New concepts, special problems and attempts at solutions
p 658 N91-23154
Turbojet potential for hypersonic flight
p 658 N91-23155
Compact heat exchanger for an inverse components engine p 659 N91-23157
Design considerations for combined air breathing-rocket propulsion systems
[AIAA-90-0098] p 659 N91-23158
Supersonic-hypersonic inlet studies for aerospaceplane p 659 N91-23160
PROPULSION SYSTEM PERFORMANCE
Performance of an aerospace plane propulsion nozzle
p 615 A91-37769
Vectored propulsion, supermaneuverability and robot aircraft --- Book p 649 A91-40501
NASA aeropropulsion research in support of propulsion systems of the 21st century
[NASA-TM-104403] p 627 N91-23083
Airbreathing propulsion for space transport: New concepts, special problems and attempts at solutions
p 658 N91-23154
Turbojet potential for hypersonic flight
p 658 N91-23155
Airbreathing propulsion for transatmospheric flight
p 659 N91-23156
Compact heat exchanger for an inverse components engine p 659 N91-23157
Design considerations for combined air breathing-rocket propulsion systems
[AIAA-90-0098] p 659 N91-23158
Supersonic-hypersonic inlet studies for aerospaceplane p 659 N91-23160
Performance characteristics of hypersonic detonation wave ramjets p 659 N91-23168
Analytical and experimental investigations of the oblique detonation wave engine concept p 660 N91-23169
The certification of the aircraft integrated propulsive system
[REPT-911-111-102] p 661 N91-23188

PROPULSIVE EFFICIENCY
Integration of propulsive systems: Selection and compromise
[REPT-911-111-101] p 661 N91-23187
The certification of the aircraft integrated propulsive system
[REPT-911-111-102] p 661 N91-23188
An efficient hybrid scheme for the solution of rotational flow around advanced propellers p 629 N91-24104
Developing and utilizing an Euler computational method for predicting the airframe/propulsion effects for an aft-mounted turboprop transport. Volume 1: Theory document
[NASA-CR-181924-VOL-1] p 632 N91-24118
PROTECTION
Lightning protection requirements for aircraft: A proposed specification
[RAE-TM-FS(F)-632-ISSUE-1-R] p 641 N91-24186
PROTECTIVE CLOTHING
Northrop advanced fighter crew protection system. I - Engineering development. II - System development, test and evaluation p 647 A91-39395
PROTECTIVE COATINGS
Robotic sensors for aircraft paint stripping
[SME PAPER MS90-282] p 673 A91-36896
Aircraft repair/general aviation quick tooling
[SME PAPER EM90-178] p 611 A91-36944
PSEUDOPOTENTIALS
A new pseudo-potential function model for rotational flow and its application to transonic-supersonic flow p 625 A91-40373
PULSE DOPPLER RADAR
All solid-state ASR with adaptive pulse Doppler processing p 641 A91-37107
Radar simulation program upgrade and algorithm development p 638 N91-24153
PULSES
Feasibility study in crack detection in aircraft stiffened panels by pulse probing and deconvolution p 654 N91-24158
PUMP IMPELLERS
Fluid Machinery Forum - 1990; ASME Spring Meeting, University of Toronto, Canada, June 4-7, 1990, Proceedings p 676 A91-38869
Toward automating the design of centrifugal impellers p 676 A91-38874

Q

QUALIFICATIONS
Analytical Qualification of Aircraft Structures
[AGARD-R-772] p 683 N91-24638
Evaluation of the qualification of the structure of a passenger aircraft by analysis and full-scale testing p 684 N91-24645
The role of analysis in the design and qualification of composite aircraft structures p 684 N91-24648
Influence of the refinement of structural calculation on aircraft qualification procedures p 684 N91-24649
Analytical methods for the qualification of helicopter structures p 684 N91-24650
QUALITY CONTROL
NKK premium quality titanium master alloy p 672 A91-40425
NASA-LaRc Flight-Critical Digital Systems Technology Workshop
[NASA-CP-10028] p 655 N91-24200
QUATERNIONS
Real time estimation of aircraft angular attitude
[IAITIC-87-1004] p 649 N91-23107

R

RADAR ANTENNAS
Precision runway monitor demonstration report
[AD-A232671] p 669 N91-23198
RADAR APPROACH CONTROL
Precision runway monitor demonstration report
[AD-A232671] p 669 N91-23198
RADAR CLUTTER MAPS
Measurement of clutter suppression using a Quadrahedral p 674 A91-37106
RADAR CROSS SECTIONS
The planar elements method for computing the scattering field of flight vehicle p 674 A91-37052
RADAR DATA
Radar simulation program upgrade and algorithm development p 638 N91-24153
RADAR DETECTION
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 2
[NASA-CP-10060-PT-2] p 636 N91-24140
Airborne radar simulation studies of the Denver July 11, 1988 microburst p 638 N91-24155
RADAR IMAGERY
Evaluation of the phase distortions of the input signal of a synthetic-aperture radar p 677 A91-39144
CLASS: Coherent Lidar Airborne Shear Sensor. Windshear avoidance
[LMSC-F-415048] p 636 N91-24141
Clutter modeling of the Denver Airport and surrounding areas p 638 N91-24152
Airborne radar simulation studies of the Denver July 11, 1988 microburst p 638 N91-24155
Description, characteristics and testing of the NASA airborne radar p 638 N91-24156
RADAR SCATTERING
The planar elements method for computing the scattering field of flight vehicle p 674 A91-37052
RADAR SIGNATURES
Pulse Doppler signature of a rotary-wing aircraft p 643 A91-39756
RADAR TARGETS
Relative effectiveness of 2-D vs. 1-D high resolution microwave imageing p 641 A91-37094
Measurement of clutter suppression using a Quadrahedral p 674 A91-37106
RADIATION EFFECTS
Surface activation of Concorde by Be-7 p 690 N91-24983
RADIO BEACONS
Characteristics of the reception by the antenna systems of a descending aircraft of signals from radio-beacon landing systems p 642 A91-37200
RADIO COMMUNICATION
SATURN: The next generation radio for NATO p 682 N91-24475
RADIO NAVIGATION
Functional-adaptive data processing in airborne radio navigation and landing systems p 643 A91-39187
RADIO TRANSMISSION
Orientation measurements and transmission via Mode S at airports p 643 A91-38526
RAIN
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 1
[NASA-CP-10060-PT-1] p 639 N91-24166
RADAR performance experiments p 639 N91-24168
Status of heavy rain tests p 640 N91-24180
Estimate of heavy rain performance effect p 640 N91-24182
RAMJET ENGINES
Accent on hypersonic p 669 A91-36625
Hypersonic Combined Cycle Propulsion
[AGARD-CP-479] p 657 N91-23147
Hypersonic propulsion: Past and present p 657 N91-23148
A study of supersonic and hypersonic ramjet engines in France from 1950 to 1974 (application on combined cycle aircraft engines) p 658 N91-23149
Trajectory optimization considerations for ramjet engines p 658 N91-23151
Airbreathing propulsion for transatmospheric flight p 659 N91-23156
Design techniques for dual mode ram-scramjet combustors p 659 N91-23166
Performance characteristics of hypersonic detonation wave ramjets p 659 N91-23168
Theoretical and experimental performance of a solid fuel ramjet combustion cycle for hypersonic flight conditions p 660 N91-23170
An experimental evaluation of combustor liner materials for solid fuel ramjet testing p 670 N91-24289
REACTION KINETICS
Kinetic study of a homogeneous propellant primary flame, with and without additive p 671 A91-39690
Theoretical and experimental performance of a solid fuel ramjet combustion cycle for hypersonic flight conditions p 660 N91-23170
Fuel-rich, catalytic reaction experimental results
[NASA-TM-104423] p 662 N91-24203
REAL GASES
Real gas effects on hypersonic boundary-layer stability p 614 A91-36453
REAL TIME OPERATION
Evaluation of the performance of a RISC based real time data processor in air traffic control radar applications p 642 A91-37145
Integration of vibration test and flutter analysis - A brief introduction to 'a real-time flutter analysis system' p 665 A91-40168
Interferometric investigation of supersonic flow fields with shock-shock interactions p 627 N91-23082
Microwave landing system modeling with application to air traffic control
[NASA-TM-102832] p 636 N91-23099
Design and implementation of real-time computer coordinated force actuating system with multi-input/output
[AD-A233114] p 687 N91-24768
REATTACHED FLOW
The effect of isolated roughness elements on transition in attachment-line flows p 678 A91-39959
RECOVERY PARACHUTES
Recent escape system parachute efforts at Douglas Aircraft Company p 635 A91-39393
RECTANGULAR PANELS
Calculation and experimental study on sonic fatigue life of aircraft structural panels p 648 A91-40162
RECTANGULAR WINGS
Modeling for unsteady aerodynamics of rectangular wing in incompressible flow using step responses p 625 A91-40473
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 3: Unsteady
[AD-A233569] p 631 N91-24115
REDUNDANCY
Sensor failure detection for jet engines p 656 A91-37593
REENTRY VEHICLES
How to know CMC
[REPT-911-430-130] p 672 N91-23262
REGULATIONS
US industry enters the green maze --- new environmental regulations affecting aerospace companies p 685 A91-37049
The certification of the aircraft integrated propulsive system
[REPT-911-111-102] p 661 N91-23188
An overview of information resources in aviation p 690 N91-24091
Beechcraft starship strength certification p 684 N91-24643
REINFORCED PLASTICS
Study of thermal-expansion-molded, graphite-epoxy hat-stiffened sandwich panels p 675 A91-37845
REINFORCEMENT (STRUCTURES)
A new technique and application for nonlinear acoustic fatigue of stiffened composite panels p 687 A91-38863
RELIABILITY
Quantitative nondestructive evaluation: Requirements for tomorrow's reliability p 681 N91-24074
RELIABILITY ANALYSIS
Design of aircraft wings subjected to gust loads - A safety index based approach p 675 A91-37851
Similarities and differences between environment tests and reliability tests in view of vibration p 665 A91-40166
Model sensitivity in stress-strength reliability computations
[AD-A232023] p 681 N91-23554
Probability approach for strength calculations p 685 N91-24652
RELIABILITY ENGINEERING
NASA-LaRc Flight-Critical Digital Systems Technology Workshop
[NASA-CP-10028] p 655 N91-24200
REMOTE SENSORS
Coherent lidar airborne windshear sensor - Performance evaluation p 655 A91-39873
REMOTELY PILOTED VEHICLES
Vectored propulsion, supermaneuverability and robot aircraft --- Book p 649 A91-40501
REMOVAL
Automatic aircraft paint stripping
[SME PAPER MS90-280] p 611 A91-36895
Robotic sensors for aircraft paint stripping
[SME PAPER MS90-282] p 673 A91-36896
Mechanical paint removal techniques for composite aircraft p 613 N91-24163
REQUIREMENTS
Quantitative nondestructive evaluation: Requirements for tomorrow's reliability p 681 N91-24074
RESCUE OPERATIONS
Canopy breaking system for non-delay pilot rescue p 647 A91-39398
Airborne rescue system
[NASA-CASE-ARC-11909-1] p 635 N91-23095
RESEARCH
A test of the American Safety Flight Systems, Inc. prebreather/portable oxygen system
[AD-A232723] p 636 N91-23100
RESEARCH AIRCRAFT
Effects of horizontal tail ice on longitudinal aerodynamic derivatives p 665 A91-38547
RESEARCH AND DEVELOPMENT
Toward enhanced fighter combat effectiveness p 645 A91-37050
The development and research on CAD for education on aircraft design p 686 A91-38234

The costs and benefits of aircraft availability
[AD-A232660] p 613 N91-23076
Mechanical component diagnostic system
[AD-A232126] p 656 N91-23146
Activities report of the DLR
[ISSN-0938-2194] p 691 N91-24086
Status of Sundstrand research p 640 N91-24183

RESEARCH FACILITIES
Wright Laboratory --- review of aerospace research p 611 A91-36351
Activities report of the DLR
[ISSN-0938-2194] p 691 N91-24086

RESEARCH MANAGEMENT
Small Engine Component Technology (SECT) study
[NASA-CR-175081] p 663 N91-24207

RESEARCH PROJECTS
Activities report of the DLR
[ISSN-0938-2194] p 691 N91-24086

RESIDUAL STRENGTH
Environmental exposure effects on composite materials for commercial aircraft
[NASA-CR-187478] p 672 N91-24358

RESIDUAL STRESS
Residual stress control in developing processes for the manufacture of compressor blades for gas turbine engines p 674 A91-37269

RESONANT FREQUENCIES
An initial study into the influence of control stick characteristics on the handling qualities of a fly-by-wire helicopter p 651 N91-23122
Feasibility study in crack detection in aircraft stiffened panels by pulse probing and deconvolution p 654 N91-24158

RESONANT VIBRATION
Prediction of test spectrum for gunfire vibration p 666 A91-40175

REYNOLDS NUMBER
On the development of turbulent spots in plane Poiseuille flow p 678 A91-39904
Transition research in low-disturbance high-speed wind tunnels p 621 A91-39919
Aerodynamic characteristics of crescent and elliptic wings at high angles of attack p 624 A91-40219
National Transonic Facility status p 669 N91-24133
Reynolds number effects on the transonic aerodynamics of a slender wing-body configuration p 634 N91-24134
Simulation of the flow past an impulsively started cylinder using a discrete vortex method
[AD-A233066] p 683 N91-24533

RIBS (SUPPORTS)
The design, manufacture, and test of a one-piece thermoplastic wing rib for tiltrotor aircraft
[SME PAPER EM90-665] p 645 A91-36940

RIGID ROTORS
Rotor-fuselage dynamics of helicopter air and ground resonance p 645 A91-36357
Stability of hingeless rotors in hover using three-dimensional unsteady aerodynamics p 663 A91-36358

RISK
Near midair collisions as an indicator of general aviation collision risk p 635 N91-23096

ROBOT ARMS
The introduction of off-line programming techniques for the robotic assembly of aircraft structures
[SME PAPER MS90-276] p 611 A91-36898

ROBOT CONTROL
Automatic aircraft paint stripping
[SME PAPER MS90-280] p 611 A91-36895

ROBOT SENSORS
Robotic sensors for aircraft paint stripping
[SME PAPER MS90-282] p 673 A91-36896

ROBOTICS
Evaluation of automation for inspection of aging aircraft p 613 N91-24088

ROBUSTNESS (MATHEMATICS)
Control law synthesis and stability robustness improvement using constrained optimization techniques p 686 A91-37591
Robust eigenstructure assignment with structured state space uncertainty p 686 A91-39417

ROCKET CATAPULTS
Ejection seat rocket catapult design for reduced G field influence p 646 A91-39385

ROCKET ENGINE DESIGN
Design considerations for combined air breathing-rocket propulsion systems
[AIAA-90-0098] p 659 N91-23158

ROLL
Metrics for roll response flying qualities p 650 N91-23118
An initial study into the influence of control stick characteristics on the handling qualities of a fly-by-wire helicopter p 651 N91-23122

ROLLING MOMENTS
Static measurements of slender delta wing rolling moment hysteresis p 625 A91-40223

ROTARY WING AIRCRAFT
Pulse Doppler signature of a rotary-wing aircraft p 643 A91-39756
An investigation into the use of side-arm control for civil rotorcraft applications p 667 N91-23123
Technology needs for high-speed rotorcraft
[NASA-CR-177578] p 652 N91-23136
Mechanical component diagnostic system
[AD-A232126] p 656 N91-23146
Small Engine Component Technology (SECT)
[NASA-CR-175078] p 662 N91-24205
Small Engine Component Technology (SECT) study
[NASA-CR-175081] p 663 N91-24207

ROTARY WINGS
Ground resonance of a helicopter with inter-connected blades p 645 A91-36360
New developments in the dynamic aeroelastic stability study of rotor blades p 673 A91-36698
The design, manufacture, and test of a one-piece thermoplastic wing rib for tiltrotor aircraft
[SME PAPER EM90-665] p 645 A91-36940
The breakdown of the linearized theory and the role of quadrupole sources in transonic rotor acoustics p 688 A91-39749
Preference for an inertial degree of freedom describing the teeter motion of windturbine and helicopter rotors p 679 A91-40239

ROTATING BODIES
Balancing of rotating machinery p 679 A91-40278

ROTATING FLUIDS
A new pseudo-potential function model for rotational flow and its application to transonic-supersonic flow p 625 A91-40373

ROTOR AERODYNAMICS
Model rotor icing tests in the NASA Lewis icing research tunnel
[NASA-TM-104351] p 661 N91-23184

ROTOR BLADES
New developments in the dynamic aeroelastic stability study of rotor blades p 673 A91-36698

ROTOR BODY INTERACTIONS
Rotor-fuselage dynamics of helicopter air and ground resonance p 645 A91-36357
The control of rotor vibration using squeeze-film dampers p 677 A91-39590
Aerodynamic interactions between bodies in relative motion p 629 N91-24103

ROTOR DYNAMICS
Rotor-fuselage dynamics of helicopter air and ground resonance p 645 A91-36357
Fluid Machinery Forum - 1990; ASME Spring Meeting, University of Toronto, Canada, June 4-7, 1990, Proceedings p 676 A91-38869
A general method for rotordynamic analysis p 677 A91-39585
The breakdown of the linearized theory and the role of quadrupole sources in transonic rotor acoustics p 688 A91-39749

ROTOR SPEED
Preference for an inertial degree of freedom describing the teeter motion of windturbine and helicopter rotors p 679 A91-40239

ROTORCRAFT AIRCRAFT
Optimization of rotor performance in hover using a free wake analysis p 646 A91-38548

ROTORS
The transient dynamic performances of a rotor-SFDB system during passage through resonance p 678 A91-40130
Identification strategies for crack shape determination in rotors p 679 A91-40234
Mechanical component diagnostic system
[AD-A232126] p 656 N91-23146
Modal analysis of multistage gear systems coupled with gearbox vibrations
[NASA-TM-103797] p 681 N91-23513

RUNWAYS
Precision runway monitor demonstration report
[AD-A232671] p 669 N91-23198
Literature review on geotextiles to improve pavements for general aviation airports
[AD-A232871] p 669 N91-23199

S

SAAB AIRCRAFT
Long time measurements of landing gear loads on SAAB SF-340 commuter aircraft
[FFA-TN-1990-53] p 653 N91-23138

SAFETY
A test of the American Safety Flight Systems, Inc. prebreather/portable oxygen system
[AD-A232723] p 636 N91-23100
Quantitative nondestructive evaluation: Requirements for tomorrow's reliability p 681 N91-24074
An airborne FLIR detection and warning system for low altitude wind shear p 637 N91-24147

SAFETY FACTORS
Airborne rescue system
[NASA-CASE-ARC-11909-1] p 635 N91-23095

SAFETY MANAGEMENT
The certification of the aircraft integrated propulsive system
[REPT-911-111-102] p 661 N91-23188

SAMPLING
A field-deployable digital acoustic measurement system p 689 N91-24078

SANDWICH STRUCTURES
Study of thermal-expansion-molded, graphite-epoxy hat-stiffened sandwich panels p 675 A91-37845
Application of acoustically treated honeycomb sandwich panels in noise control of aircraft cabin p 648 A91-40160

SARSAT
406 MHz ELT signal spectra for Sarsat p 643 A91-39778

SATELLITE ANTENNAS
High gain airborne antenna for satellite communications p 643 A91-39776

SATELLITE COMMUNICATION
High gain airborne antenna for satellite communications p 643 A91-39776

SATELLITE TRACKING
406 MHz ELT signal spectra for Sarsat p 643 A91-39778

SCALE MODELS
Computation of inlet reference plane flow-field for a subscale free-jet forebody/inlet model and comparison to experimental data
[AD-A232101] p 680 N91-23445
Flow visualization study of a 1/48-scale AFTI/F111 model to investigate horizontal tail flow disturbances
[NASA-TM-101698] p 633 N91-24128

SCATTERING
Microwave landing system modeling with application to air traffic control
[NASA-TM-102832] p 636 N91-23099

SCATTEROMETERS
Description, characteristics and testing of the NASA airborne radar p 638 N91-24156

SEALING
Prismatic sealed Ni-Cd battery for aircraft power p 657 A91-38178

SEATS
Crashworthiness experiments p 638 N91-24161

SECONDARY RADAR
SSR signal discrimination from garbled replies p 642 A91-37121
Airborne Collision Avoidance System (ACAS) in controlled air traffic. Aspects of reciprocal influence in Secondary Surveillance Radar (SSR) radio loads
[ETN-91-99253] p 644 N91-23105

SENSITIVITY
Model sensitivity in stress-strength reliability computations
[AD-A232023] p 681 N91-23554

SEPARATED FLOW
Unsteady separation on an impulsively set into motion Carafoli airfoil p 618 A91-38694
Simulation of brush insert for leading-edge-passage convective heat transfer
[NASA-TM-103801] p 679 N91-23409
A computationally efficient modelling of laminar separation bubbles p 680 N91-23411

SERVICE LIFE
Environmental exposure effects on composite materials for commercial aircraft
[NASA-CR-187478] p 672 N91-24358

SERVOCONTROL
Re-entry flight control of space plane using approximate perfect servo p 664 A91-37778

SERVOMECHANISMS
Design and implementation of real-time computer coordinated force actuating system with multi-input/output
[AD-A233114] p 687 N91-24768

SHADOWS
MLS mathematical model validation study using airborne MLS data from Atlantic City International Airport Boeing 727 elevation shadowing flight tests
[DOT-FAA/CT-TN90/55] p 644 N91-24190

SHEAR LAYERS
The stability to two-dimensional wakes and shear layers at high Mach numbers p 614 A91-36452

Structure of the compressible turbulent shear layer p 616 A91-37830
Unsteady wave structure near separation in a Mach 5 compression ramp interaction p 616 A91-37838
On the development of turbulent spots in plane Poiseuille flow p 678 A91-39904
Unsteady Navier-Stokes solutions for a low aspect ratio delta wing [AD-A233201] p 631 N91-24112

SHEAR PROPERTIES
Supersonic flutter analysis of clamped symmetric composite panels using shear deformable finite elements p 675 A91-37847

SHEAR STRENGTH
Spot welded thermoplastic composite access door [SME PAPER EM90-489] p 645 A91-36942

SHIELDING
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 2: Development of theory for wing shielding [NASA-CR-185192] p 688 N91-23849
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 3: Application of theory for blade loading, wakes, noise, and wing shielding [NASA-CR-185193] p 688 N91-23850

SHOCK LAYERS
Entropy effects of hypersonic flow past blunt delta wings p 615 A91-37181

SHOCK TUNNELS
An isentropic compression-heated Ludweig tube transient wind tunnel p 673 A91-36450

SHOCK WAVE INTERACTION
Unsteady wave structure near separation in a Mach 5 compression ramp interaction p 616 A91-37838
Inception length to a fully developed, fin-generated, shock-wave, boundary-layer interaction p 617 A91-37842
Interferometric investigation of supersonic flow fields with shock-shock interactions p 627 N91-23082
Some aspects of shock-wave boundary layer interaction relevant to intake flows p 628 N91-23161
Hypersonic aerodynamics fellowships [AD-A233584] p 632 N91-24116
The 3-D Navier-Stokes analysis of crossing, glancing shocks/turbulent boundary layer interactions [NASA-TM-104469] p 633 N91-24130

SHOCK WAVES
Mach 4 testing of scramjet inlet models p 615 A91-37418
Reacting shock waves in hypersonic propulsion applications p 629 N91-23174
Hypersonic aerodynamics fellowships [AD-A233584] p 632 N91-24116

SHORT TAKEOFF AIRCRAFT
The handling qualities of the STOL and maneuver technology demonstrator from specification to flight test p 666 N91-23117

SIDESLIP
A new method for estimating airspeed, attack angle and sideslip angle p 664 A91-37051

SIGNAL DISTORTION
Evaluation of the phase distortions of the input signal of a synthetic-aperture radar p 677 A91-39144

SIGNAL PROCESSING
All solid-state ASR with adaptive pulse Doppler processing p 641 A91-37107
SSR signal discrimination from garbled replies p 642 A91-37121
Pulse Doppler signature of a rotary-wing aircraft p 643 A91-39756
406 MHz ELT signal spectra for Sarsat p 643 A91-39778
Radar simulation program upgrade and algorithm development p 638 N91-24153
Signal processing techniques for clutter filtering and wind shear detection p 638 N91-24154
Description, characteristics and testing of the NASA airborne radar p 638 N91-24156
MLS mathematical model validation study using airborne MLS data from Atlantic City International Airport Boeing 727 elevation shadowing flight tests [DOT-FAA/CT-TN90/55] p 644 N91-24190
Signal processing of aircraft flyover noise [NASA-CR-187546] p 690 N91-24845

SIGNAL REFLECTION
Characteristics of the reception by the antenna systems of a descending aircraft of signals from radio-beacon landing systems p 642 A91-37200

SIGNATURE ANALYSIS
Model for IR sensor performance evaluation - Applications and results p 656 A91-39890

SIKORSKY AIRCRAFT
Model rotor icing tests in the NASA Lewis icing research tunnel [NASA-TM-104351] p 661 N91-23184

SILICON CARBIDES
Improved silicon carbide for advanced heat engines [NASA-CR-182289] p 672 N91-24451

SIMULATION
Simulation of iced wing aerodynamics [NASA-TM-104362] p 628 N91-23086
Radar simulation program upgrade and algorithm development p 638 N91-24153
Airborne radar simulation studies of the Denver July 11, 1988 microburst p 638 N91-24155

SINGLE CRYSTALS
Notched fatigue of single crystal PWA 1480 at turbine attachment temperatures p 682 N91-24310

SISO (CONTROL SYSTEMS)
Application of multiple-input/single-output analysis procedures to flight test data p 647 A91-39420

SKIN FRICTION
Viscous three-dimensional analyses for nozzles for hypersonic propulsion p 629 N91-23175

SLEDS
Crashworthiness experiments p 638 N91-24161

SLENDER BODIES
Three-dimensional finite element method analysis of turbulent flow over self-propelled slender bodies p 615 A91-37419
Asymmetric vortices on a slender body of revolution p 616 A91-37827
Computation of axisymmetric slender bodies enclosing a jet efflux in pitching oscillatory motion p 618 A91-38681

SLENDER WINGS
Aerodynamic characteristics of slender wing-gap-body combinations p 615 A91-37777
Asymptotic theory of bending-torsion flutter of high aspect ratio wing in the torsion controlled domain p 675 A91-37846
Reynolds number effects on the transonic aerodynamics of a slender wing-body configuration p 634 N91-24134

SMEAR
Signal processing of aircraft flyover noise [NASA-CR-187546] p 690 N91-24845

SMOKE DETECTORS
Aircraft Command in Emergency Situations (ACES). Phase 1: Concept development [DOT/FAA/CT-90/21] p 636 N91-23097

SODAR
MEGASODAR experiment p 639 N91-24169

SOFTWARE ENGINEERING
Validation of in-house and external software systems at Aerospatiale p 687 N91-24640
Analytical certification of aircraft structures p 684 N91-24641

SOFTWARE TOOLS
Analytical Qualification of Aircraft Structures [AGARD-R-772] p 683 N91-24638

SOLID PROPELLANT COMBUSTION
An experimental evaluation of combustor liner materials for solid fuel ramjet testing p 670 N91-24289

SOLID PROPELLANTS
An experimental evaluation of combustor liner materials for solid fuel ramjet testing p 670 N91-24289

SOLID STATE DEVICES
All solid-state ASR with adaptive pulse Doppler processing p 641 A91-37107

SOLID STATE LASERS
Avionic laser multisensor program at Litton Aero Products p 637 N91-24144

SONIC BOOMS
The 1989 high-speed civil transport studies [NASA-CR-4375] p 654 N91-24195

SOUND PRESSURE
A study on sonic load of the vertical tail of F-7 aircraft p 648 A91-40171

SOUND PROPAGATION
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 2: Development of theory for wing shielding [NASA-CR-185192] p 688 N91-23849

SOUND TRANSMISSION
ALDAS user's manual [NASA-TM-102831] p 687 N91-24757
Laboratory test and acoustic analysis of cabin treatment for propfan test assessment aircraft [NASA-CR-182075] p 690 N91-24844

SPACE EXPLORATION
The role of organizations in professional development p 690 A91-38367

SPACE SHUTTLE BOOSTERS
A dynamic analysis of the SRB parachute system [AIAA PAPER 91-0838] p 670 A91-40555

SPACE TRANSPORTATION
Activities report of the DLR [ISSN-0938-2194] p 691 N91-24086

SPACE TRANSPORTATION SYSTEM
Airbreathing propulsion for space transport: New concepts, special problems and attempts at solutions p 658 N91-23154

SPACECRAFT CONSTRUCTION MATERIALS
Titanium aluminides for aerospace applications p 671 A91-39302
Oxidation resistant carbon/carbon materials [REPT-911-430-105] p 672 N91-23251
How to know CMC [REPT-911-430-130] p 672 N91-23262

SPACECRAFT REENTRY
Boundary layer tripping in supersonic flow p 623 A91-39960

SPATIAL FILTERING
Evolution of clutter suppression techniques for air traffic control and surveillance radar p 641 A91-37101

SPATIAL RESOLUTION
Temporally and spatially resolved flow in a two-stage axial compressor. II - Computational assessment [ASME PAPER 90-GT-299] p 620 A91-39048

SPECIFICATIONS
Soft hub for bearingless rotors [NASA-CR-177586] p 654 N91-24198

SPECTROSCOPY
Feasibility study in crack detection in aircraft stiffened panels by pulse probing and deconvolution p 654 N91-24158

SPECTRUM ANALYSIS
ALDAS user's manual [NASA-TM-102831] p 687 N91-24757

SPHERICAL COORDINATES
Angle-only tracking filter in modified spherical coordinates p 643 A91-39433

SPOILERS
High subsonic flow about a moving spoiler identifying a novel problem of wind tunnel interference p 619 A91-38710
Integration of four-dimensional guidance with total energy control system --- integrated autopilot/autothrottle control system design p 665 A91-39410

SPOOLS
Airborne rescue system [NASA-CASE-ARC-11909-1] p 635 N91-23095

SPOT WELDS
Spot welded thermoplastic composite access door [SME PAPER EM90-489] p 645 A91-36942

SQUEEZE FILMS
The control of rotor vibration using squeeze-film dampers p 677 A91-39590
The transient dynamic performances of a rotor-SFDB system during passage through resonance p 678 A91-40130

STABILITY AUGMENTATION
Simulation evaluation of a speed-guidance law for Harrier approach transitions [NASA-TM-102853] p 668 N91-24209

STABILIZATION
An initial study into the influence of control stick characteristics on the handling qualities of a fly-by-wire helicopter p 651 N91-23122
Aerodynamics and stabilization of combustion of hydrogen jets injected into subsonic airflow p 629 N91-23164

STATE ESTIMATION
Real time estimation of aircraft angular attitude [IAITIC-87-1004] p 649 N91-23107

STATIC PRESSURE
An engineering study of altitude determination deficiencies of the Service Aircraft Instrumentation Package (SAIP) [AD-A232055] p 656 N91-23145

STATIC TESTS
Static measurements of slender delta wing rolling moment hysteresis p 625 A91-40223
Computerized system for static and fatigue large scale structural tests: A case study [IAITIC-87-1007] p 681 N91-23522
Static performance tests of a flight-type STOVL ejector [NASA-TM-104437] p 662 N91-24201

STATISTICAL TESTS
Model sensitivity in stress-strength reliability computations [AD-A232023] p 681 N91-23554

STEADY FLOW
Steady flow in a three-dimensional rectangular cavity yawed from the freestream turbulent boundary layer p 619 A91-38742
Steady linearised aerodynamics. III - Transonic p 620 A91-39223
Quantitative analysis of flow visualizations in ONERA water tunnels p 677 A91-39694
Rotary oscillation control of a cylinder wake p 620 A91-39708

Aerodynamics at the speed of sound
p 621 A91-39900

STRAIN MEASUREMENT
Long time measurements of landing gear loads on SAAB SF-340 commuter aircraft
[FFA-TN-1990-53] p 653 N91-23138

STREAM FUNCTIONS (FLUIDS)
Stream functions for the hypersonic flow around quasi-pointed slender bodies at low angles of attack
p 621 A91-39832

STRESS ANALYSIS
Low Altitude High Speed Cargo Parachute system development - A status report
[AIAA PAPER 91-0880] p 635 A91-40558
A new facility to study three dimensional viscous flow and rotor-stator interaction in turbines
p 682 N91-24336
Nonlinear analysis of composite shear webs with holes and correlation with tests p 684 N91-24642
Beechcraft starship strength certification
p 684 N91-24643

STRESS CONCENTRATION
Actual stresses in notches - How applicable are the common stress concentration factors?
p 676 A91-38775

STRESS CYCLES
Fatigue crack growth modeling at elevated temperature using fracture mechanics p 671 A91-38812

STRESS DISTRIBUTION
Influence of the refinement of structural calculation on aircraft qualification procedures p 684 N91-24649

STRESS INTENSITY FACTORS
Actual stresses in notches - How applicable are the common stress concentration factors?
p 676 A91-38775

STRESS MEASUREMENT
Residual stress control in developing processes for the manufacture of compressor blades for gas turbine engines p 674 A91-37269

STRIATION
An experimental investigation of vortex pair interaction with a clean or contaminated free surface
p 680 N91-23419

STRUCTURAL ANALYSIS
Numerical analysis of solid-fuel interactive vibration on an aircraft integral tank p 648 A91-40161
Analytical Qualification of Aircraft Structures
[AGARD-R-772] p 683 N91-24638
Analytical certification of aircraft structures
p 684 N91-24641
Beechcraft starship strength certification
p 684 N91-24643
The role of structural analysis in airworthiness certification p 684 N91-24647
Analytical methods for the qualification of helicopter structures p 684 N91-24650
Probability approach for strength calculations
p 685 N91-24652

STRUCTURAL DESIGN
Study of thermal-expansion-molded, graphite-epoxy hat-stiffened sandwich panels p 675 A91-37845
Designing with composites - A study of design process p 646 A91-38752
Actual stresses in notches - How applicable are the common stress concentration factors?
p 676 A91-38775
Ejection seat rocket catapult design for reduced G field influence p 646 A91-39385
The Minipac II ejection seat program
p 647 A91-39390
Design techniques for dual mode ram-scramjet combustors p 659 N91-23166
Development of a quiet supersonic wind tunnel with a cryogenic adaptive nozzle
[NASA-CR-186769] p 669 N91-23195
AGARD highlights 91/1, March 1991
[AGARD-HIGHLIGHTS-91/1] p 691 N91-24084
Soft hub for bearingless rotors
[NASA-CR-177586] p 654 N91-24198
Nonlinear analysis of composite shear webs with holes and correlation with tests p 684 N91-24642
The role of analysis in the design and qualification of composite aircraft structures p 684 N91-24648

STRUCTURAL DESIGN CRITERIA
Air surveying and data analysis for dynamic response of missiles at swept-back wing tip p 647 A91-40156

STRUCTURAL FAILURE
Quantitative nondestructive evaluation: Requirements for tomorrow's reliability p 681 N91-24074
Program plans for aviation safety research
[NIAR-90-32] p 638 N91-24157
Analytical methods for the qualification of helicopter structures p 684 N91-24650

STRUCTURAL INFLUENCE COEFFICIENTS
Analytical studies on static aeroelastic behavior of forward-swept composite wing structures
p 674 A91-37774

STRUCTURAL RELIABILITY
Design of aircraft wings subjected to gust loads - A safety index based approach p 675 A91-37851

STRUCTURAL STABILITY
Sensitivity analysis, optimization, and data support in finite element systems p 677 A91-39230
Vibration behavior of a labyrinth seal with through-flow
p 679 A91-40241

STRUCTURAL VIBRATION
Full-scale demonstration tests of cabin noise reduction using active vibration control p 646 A91-38549
The control of rotor vibration using squeeze-film dampers p 677 A91-39590
Numerical analysis of solid-fuel interactive vibration on an aircraft integral tank p 648 A91-40161
Vibration problems in an aircraft design
p 648 A91-40165
Similarities and differences between environment tests and reliability tests in view of vibration
p 665 A91-40166
Balancing of rotating machinery p 679 A91-40278

SUBSONIC AIRCRAFT
Aircraft performance p 649 A91-40511

SUBSONIC FLOW
New methods in the theory of subsonic flows past thin airfoil configurations p 614 A91-36699
Subsonic and supersonic combustion using noncircular injectors p 674 A91-37414
Three-dimensional composite velocity solutions for subsonic/transonic flow p 616 A91-37841
High subsonic flow about a moving spoiler identifying a novel problem of wind tunnel interference
p 619 A91-38710
Procedure for determination of three-dimensional wind tunnel wall interferences and wall adaptation in compressible subsonic flow using measured wall pressures
[DLR-FB-90-46] p 628 N91-23088

SUBSONIC WIND TUNNELS
Aerodynamic characteristics of crescent and elliptic wings at high angles of attack p 624 A91-40219

SUCTION
The NASA Langley laminar-flow-control experiment on a swept, supercritical airfoil: Suction coefficient analysis
[NASA-TM-4267] p 629 N91-24098
Suckdown, fountain lift, and pressures induced on several tandem jet V/STOL configurations
[NASA-TM-102817] p 630 N91-24108

SUPERCHARGERS
Model 320-2: A compact advanced UAV turbojet
p 663 N91-24292

SUPERCRITICAL WINGS
Blunt-nosed swept supercritical LFC wings without nose flaps p 622 A91-39936
The NASA Langley laminar-flow-control experiment on a swept, supercritical airfoil: Suction coefficient analysis
[NASA-TM-4267] p 629 N91-24098

SUPERSONIC AIRCRAFT
Theoretical evaluation of engine auxiliary inlet design for supersonic V/STOL aircraft
[NASA-CR-187098] p 633 N91-24123

SUPERSONIC BOUNDARY LAYERS
Second mode interactions in supersonic boundary layers p 623 A91-39957

SUPERSONIC COMBUSTION
Subsonic and supersonic combustion using noncircular injectors p 674 A91-37414
Experimental investigation on supersonic combustion
p 657 A91-38203
Hypersonic propulsion: Past and present
p 657 N91-23148

SUPERSONIC COMBUSTION RAMJET ENGINES
Mach 4 testing of scramjet inlet models
p 615 A91-37418
Performance of an aerospace plane propulsion nozzle
p 615 A91-37769
Effect of exhaust plume/afterbody interaction on installed scramjet performance p 615 A91-37770
Experimental investigation on supersonic combustion
p 657 A91-38203
Comparative study of different systems of combined cycle propulsion p 658 N91-23152
Hypersonic propulsion: Status and challenge
p 658 N91-23153
Design techniques for dual mode ram-scramjet combustors p 659 N91-23166

SUPERSONIC COMPRESSORS
Viscous design and analysis methods for transonic compressor blading
[AD-A232902] p 682 N91-24530

SUPERSONIC FLIGHT
Calculation of steady and unsteady pressures on wings at supersonic speeds with a transonic small-disturbance code p 617 A91-38544
Trajectory optimization considerations for ramjet engines p 658 N91-23151

SUPERSONIC FLOW
On the improvement of the supersonic lifting line theory p 614 A91-36695
Wing calculation in supersonic flow by means of the supersonic lifting line theory p 614 A91-36700
Aerodynamic calculation of tandem wings in supersonic flow by means of SLLT p 614 A91-36724
Variable-property effects in supersonic wedge flow
p 616 A91-37832
Cycle analysis for a supersonic through flow fan engine p 657 A91-38207
Aerodynamics at the speed of sound
p 621 A91-39900
Boundary layer tripping in supersonic flow
p 623 A91-39960
A new pseudo-potential function model for rotational flow and its application to transonic-supersonic flow
p 625 A91-40373
Interferometric investigation of supersonic flow fields with shock-shock interactions p 627 N91-23082
The effects on aerodynamic performance of designing supersonic wings for laminar flow control
[AD-A233040] p 654 N91-24197

SUPERSONIC FLUTTER
Supersonic flutter analysis of clamped symmetric composite panels using shear deformable finite elements p 675 A91-37847

SUPERSONIC INLETS
Supersonic-hypersonic inlet studies for aerospaceplane p 659 N91-23160
Theoretical evaluation of engine auxiliary inlet design for supersonic V/STOL aircraft
[NASA-CR-187098] p 633 N91-24123

SUPERSONIC NOZZLES
The 2-D supersonic nozzle design
p 660 N91-23176

SUPERSONIC SPEED
Interferometric investigation of supersonic flow fields with shock-shock interactions p 627 N91-23082
A study of supersonic and hypersonic ramjet engines in France from 1950 to 1974 (application on combined cycle aircraft engines) p 658 N91-23149
Theoretical and experimental performance of a solid fuel ramjet combustion cycle for hypersonic flight conditions
p 660 N91-23170

SUPERSONIC TRANSPORTS
Euler analysis of a High-Speed Civil Transport concept at Mach 3 p 624 A91-40217
Engine technology challenges for a 21st century high speed civil transport
[NASA-TM-104363] p 636 N91-23098
Application of multidisciplinary optimization methods to the design of a supersonic transport
[NASA-TM-104073] p 652 N91-23135
The 1989 high-speed civil transport studies
[NASA-CR-4375] p 654 N91-24195

SUPERSONIC WIND TUNNELS
Structure of the compressible turbulent shear layer
p 616 A91-37830
Dialogue on progress and issues in stability and transition research p 677 A91-39902
Transition research in low-disturbance high-speed wind tunnels p 621 A91-39919
Interferometric investigation of supersonic flow fields with shock-shock interactions p 627 N91-23082
Development of a quiet supersonic wind tunnel with a cryogenic adaptive nozzle
[NASA-CR-186769] p 669 N91-23195

SUPPORT SYSTEMS
Hot gas ingestion test results of a two-poster vectored thrust concept with flow visualization in the NASA Lewis 9- by 15-foot low speed wind tunnel
[AIAA PAPER 90-2268] p 626 A91-40561

SURFACE GEOMETRY
Flow around an unsteady thin wing close to curved ground p 620 A91-39744
On the stability of swept wing laminar boundary layers including curvature effects p 622 A91-39933

SURFACE ROUGHNESS EFFECTS
The effect of isolated roughness elements on transition in attachment-line flows p 678 A91-39959

SURFACE TEMPERATURE
Simulation of brush insert for leading-edge-passage convective heat transfer
[NASA-TM-103801] p 679 N91-23409

SURVEILLANCE RADAR
Evolution of clutter suppression techniques for air traffic control and surveillance radar p 641 A91-37101
SSR signal discrimination from garbled replies
p 642 A91-37121

Airborne Collision Avoidance System (ACAS) in controlled air traffic. Aspects of reciprocal influence in Secondary Surveillance Radar (SSR) radio loads
[ETN-91-99253] p 644 N91-23105

SURVIVAL EQUIPMENT
An update on SKAD (survival kit air droppable) systems p 635 A91-39384

SWEEP ANGLE
Breaking down the delta wing vortex: The role of vorticity in the breakdown process
[NASA-CR-188235] p 630 N91-24109

SWEPT FORWARD WINGS
Forward sweep - A favorable concept for a laminar flow wing p 615 A91-37767
Analytical studies on static aeroelastic behavior of forward-swept composite wing structures p 674 A91-37774
Flying qualities of the X-29 forward swept wing aircraft p 651 N91-23127

SWEPT WINGS
Analytical studies on static aeroelastic behavior of forward-swept composite wing structures p 674 A91-37774
Interactive three-dimensional boundary-layer method for transonic flow over swept wings p 616 A91-37829
A model for the experimental study of curvature effects on transition of the boundary layer on a swept wing - Preliminary results p 620 A91-39691
Boundary layer control by a local heating of the wall p 678 A91-39909
Experimental and theoretical analysis of natural transition on 'infinite' swept wing p 621 A91-39927
An evaluation of stability-based methods for transition of three-dimensional flows p 678 A91-39928
Experiments on swept-wing boundary layers p 622 A91-39932
On the stability of swept wing laminar boundary layers including curvature effects p 622 A91-39933
Blunt-nosed swept supercritical LFC wings without nose flaps p 622 A91-39936
Instability features appearing on swept wing configurations p 622 A91-39937
Development and interaction of instabilities in the crossflow field p 622 A91-39938
The experimental investigation of stability and receptivity of a swept-wing flow p 623 A91-39944
The effect of isolated roughness elements on transition in attachment-line flows p 678 A91-39959
Block implicit multigrid solution of the Euler equations p 680 N91-23413
The NASA Langley laminar-flow-control experiment on a swept, supercritical airfoil: Suction coefficient analysis
[NASA-TM-4267] p 629 N91-24098
Computational support of the X-29A Advanced Technology Demonstrator flight experiment p 653 N91-24137
Results of correlations for transition location on a clean-up glove installed on an F-14 aircraft and design studies for a laminar glove for the X-29 aircraft accounting for spanwise pressure gradient p 654 N91-24138

SWEPTBACK WINGS
Cross-flow instability of 3-D boundary layers on a flat plate p 622 A91-39931
Air surveying and data analysis for dynamic response of missiles at swept-back wing tip p 647 A91-40156
Design and implementation of real-time computer coordinated force actuating system with multi-input/output
[AD-A233114] p 687 N91-24768

SYNTHETIC APERTURE RADAR
Evaluation of the phase distortions of the input signal of a synthetic-aperture radar p 677 A91-39144
Clutter modeling of the Denver Airport and surrounding areas p 638 N91-24152

SYSTEMS ANALYSIS
Aerodynamic preliminary analysis system 2. Part 2: User's manual
[NASA-CR-182077] p 627 N91-23081

SYSTEMS ENGINEERING
The transient dynamic performances of a rotor-SFDB system during passage through resonance p 678 A91-40130
NASA-LaRc Flight-Critical Digital Systems Technology Workshop
[NASA-CP-10028] p 655 N91-24200

SYSTEMS INTEGRATION
Integration of four-dimensional guidance with total energy control system --- integrated autopilot/autothrottle control system design p 665 A91-39410
Application of multidisciplinary optimization methods to the design of a supersonic transport
[NASA-TM-104073] p 652 N91-23135
Integration of weather sensing devices p 639 N91-24174
TDWR information on the flight deck p 640 N91-24176
Integration of the TDWR and LLWAS wind shear detection system p 640 N91-24178
National airspace system. Communications operational concept NAS-SR-136
[DOT/FAA/SE-91/1] p 640 N91-24185

T

T-39 AIRCRAFT
Saberliner flight test for airborne wind shear forward looking detection and avoidance radar systems p 637 N91-24149

TAIL ASSEMBLIES
Metal matrix composite vertical tail fabrication
[SME PAPER EM90-438] p 611 A91-36875
Design and construction of a composite airframe for UAV research
[AD-A232422] p 653 N91-23143

TAIL ROTORS
Model rotor icing tests in the NASA Lewis icing research tunnel
[NASA-TM-104351] p 661 N91-23184

TAIL SURFACES
A study on sonic load of the vertical tail of F-7 aircraft p 648 A91-40171

TAKEOFF
Microwave landing system modeling with application to air traffic control
[NASA-TM-102832] p 636 N91-23099

TAKEOFF RUNS
Orientation measurements and transmission via Mode S at airports p 643 A91-38526

TANDEM WING AIRCRAFT
Aerodynamic calculation of tandem wings in supersonic flow by means of SLLT p 614 A91-36724

TARGET RECOGNITION
Measurement of clutter suppression using a Quadrahedral p 674 A91-37106
Track initiation using MHT in dense environments --- Multiple Hypotesis Tracking p 674 A91-37141

TECHNOLOGICAL FORECASTING
Comanche - Tomorrow's high-tech helicopter p 649 A91-40254

TECHNOLOGY ASSESSMENT
Toward enhanced fighter combat effectiveness p 645 A91-37050
Tiltrotor developments p 612 A91-40180
Technology needs for high-speed rotorcraft
[NASA-CR-177578] p 652 N91-23136
Development of a quiet supersonic wind tunnel with a cryogenic adaptive nozzle
[NASA-CR-186769] p 669 N91-23195
NASA-LaRc Flight-Critical Digital Systems Technology Workshop
[NASA-CP-10028] p 655 N91-24200
Small Engine Component Technology (SECT) study. Program report
[NASA-CR-175077] p 662 N91-24204
Small Engine Component Technology (SECT)
[NASA-CR-175078] p 662 N91-24205
Small Engine Component Technology (SECT) study
[NASA-CR-175081] p 663 N91-24207
Small Engine Component Technology (SECT) study
[NASA-CR-175079] p 663 N91-24208
Advanced Hypervelocity Aerophysics Facility Workshop
[NASA-CP-10031] p 669 N91-24211

TECHNOLOGY UTILIZATION
Design and construction of a composite airframe for UAV research
[AD-A232422] p 653 N91-23143
Integration of weather sensing devices p 639 N91-24174

TEETERING
Model rotor icing tests in the NASA Lewis icing research tunnel
[NASA-TM-104351] p 661 N91-23184

TEMPERATURE DISTRIBUTION
Water-cooling technique of high temperature gas turbine blade
[DE91-764238] p 681 N91-23506

TEMPERATURE EFFECTS
Real gas effects on hypersonic boundary-layer stability p 614 A91-36453
Environmental exposure effects on composite materials for commercial aircraft
[NASA-CR-187478] p 672 N91-24358
Advanced thermally stable jet fuels development program annual report. Volume 3: Fuel lubricity
[AD-A232793] p 673 N91-24453

TEMPERATURE PROFILES
Airfoil transition and separation studies using an infrared imaging system p 624 A91-40215

TEMPORAL RESOLUTION
Temporally and spatially resolved flow in a two-stage axial compressor. II - Computational assessment
[ASME PAPER 90-GT-299] p 620 A91-39048

TENSILE STRENGTH
Application of path-independent integrals to elevated temperature crack growth p 671 A91-38819

TEST FACILITIES
Hypersonic propulsion: Status and challenge p 658 N91-23153
National Transonic Facility status p 669 N91-24133

TEST PILOTS
The art of flying qualities testing p 649 N91-23109

TEST STANDS
Development of B-1 antenna measurement test bed p 668 A91-37881

THERMAL EXPANSION
Study of thermal-expansion-molded, graphite-epoxy hat-stiffened sandwich panels p 675 A91-37845

THERMAL FATIGUE
Modeling of creep-fatigue interaction effects on crack growth p 670 A91-38802

THERMAL RESISTANCE
Variable-property effects in supersonic wedge flow p 616 A91-37832

THERMAL STABILITY
Advanced thermally stable jet fuels development program annual report. Volume 3: Fuel lubricity
[AD-A232793] p 673 N91-24453

THERMAL STRESSES
Water-cooling technique of high temperature gas turbine blade
[DE91-764238] p 681 N91-23506

THERMODYNAMICS
Thermodynamic Alerter for Microbursts (TAMP) p 640 N91-24179

THERMOPLASTIC RESINS
The design, manufacture, and test of a one-piece thermoplastic wing rib for tiltrotor aircraft
[SME PAPER EM90-665] p 645 A91-36940

THIN AIRFOILS
New methods in the theory of subsonic flows past thin airfoil configurations p 614 A91-36699
An efficient hybrid scheme for the solution of rotational flow around advanced propellers p 629 N91-24104

THIN WINGS
Flow around an unsteady thin wing close to curved ground p 620 A91-39744

THREE DIMENSIONAL BOUNDARY LAYER
Discontinuous solutions for a three-dimensional hypersonic boundary layer with interaction p 614 A91-37176
Interactive three-dimensional boundary-layer method for transonic flow over swept wings p 616 A91-37829
Steady flow in a three-dimensional rectangular cavity yawed from the freestream turbulent boundary layer p 619 A91-38742
A model for the experimental study of curvature effects on transition of the boundary layer on a swept wing - Preliminary results p 620 A91-39691
Cross-flow instability of 3-D boundary layers on a flat plate p 622 A91-39931
Experiments on swept-wing boundary layers p 622 A91-39932
Development and interaction of instabilities in the crossflow field p 622 A91-39938
A study of three dimensional turbulent boundary layer separation and vortex flow control using the reduced Navier Stokes equations
[NASA-TM-104407] p 628 N91-23089

THREE DIMENSIONAL FLOW
Discontinuous solutions for a three-dimensional hypersonic boundary layer with interaction p 614 A91-37176
Three-dimensional finite element method analysis of turbulent flow over self-propelled slender bodies p 615 A91-37419
Three-dimensional composite velocity solutions for subsonic/transonic flow p 616 A91-37841
Toward automating the design of centrifugal impellers p 676 A91-38874
Boundary layer control by a local heating of the wall p 678 A91-39909
Experimental and theoretical analysis of natural transition on 'infinite' swept wing p 621 A91-39927
An evaluation of stability-based methods for transition of three-dimensional flows p 678 A91-39928
Boundary layer tripping in supersonic flow p 623 A91-39960
Computation of three-dimensional flow fields through compressor blade rows p 625 A91-40375
Analysis of numerical solutions for three-dimensional lifting wing flows p 625 A91-40498

Procedure for determination of three-dimensional wind tunnel wall interferences and wall adaptation in compressible subsonic flow using measured wall pressures
[DLR-FB-90-46] p 628 N91-23088
Block implicit multigrid solution of the Euler equations p 680 N91-23413
The 3-D Navier-Stokes analysis of crossing, glancing shocks/turbulent boundary layer interactions
[NASA-TM-104469] p 633 N91-24130

THREE DIMENSIONAL MODELS
Advanced computational models for analyzing high speed propulsive flowfields p 686 N91-24291

THRUST VECTOR CONTROL
Vectored propulsion, supermaneuverability and robot aircraft --- Book p 649 A91-40501
Hot gas ingestion test results of a two-poster vectored thrust concept with flow visualization in the NASA Lewis 9- by 15-foot low speed wind tunnel
[AIAA PAPER 90-2268] p 626 A91-40561

THRUST-WEIGHT RATIO
A general method for rotordynamic analysis p 677 A91-39585

THUNDERSTORMS
Temperature lapse rate as an adjunct to wind shear detection p 640 N91-24184

TILT ROTOR AIRCRAFT
The design, manufacture, and test of a one-piece thermoplastic wing rib for tiltrotor aircraft
[SME PAPER EM90-665] p 645 A91-36940
Tiltrotor developments p 612 A91-40180

TILT WING AIRCRAFT
Technology needs for high-speed rotorcraft
[NASA-CR-177578] p 652 N91-23136

TILTING ROTORS
Soft hub for bearingless rotors
[NASA-CR-177586] p 654 N91-24198

TIME DEPENDENCE
Modeling of creep-fatigue interaction effects on crack growth p 670 A91-38802
Fatigue crack growth modeling at elevated temperature using fracture mechanics p 671 A91-38812

TIME SERIES ANALYSIS
Normalized predictive deconvolution - Multichannel time-series applications to human dynamics p 686 A91-37584

TITANIUM ALLOYS
Residual stress control in developing processes for the manufacture of compressor blades for gas turbine engines p 674 A91-37269
Fatigue crack growth in monolithic titanium aluminides p 670 A91-38809
NKK premium quality titanium master alloy p 672 A91-40425

TITANIUM COMPOUNDS
Titanium aluminides for aerospace applications p 671 A91-39302
Radioluminescent (RL) lighting system development program
[DE91-009743] p 679 N91-23381

TOLLMIEN-SCHLICHTING WAVES
On the development of turbulent spots in plane Poiseuille flow p 678 A91-39904
On the instability of hypersonic flow past a wedge p 621 A91-39922
Theoretical study of Goertler vortices - Linear stability approach p 623 A91-39950

TOOLING
Moulded Mustang p 612 A91-39854

TORSION
Asymptotic theory of bending-torsion flutter of high aspect ratio wing in the torsion controlled domain p 675 A91-37846

TRACKING (POSITION)
Adaptive airborne track while scan p 642 A91-37139
The handling qualities of the STOL and maneuver technology demonstrator from specification to flight test p 666 N91-23117

TRACKING FILTERS
Track initiation using MHT in dense environments --- Multiple Hypotesis Tracking p 674 A91-37141
Angle-only tracking filter in modified spherical coordinates p 643 A91-39433

TRACKING PROBLEM
Lateral-direction tracking requirements from simulation data p 686 A91-39436

TRAILING EDGES
Experimental investigation of loading effects on compressor trailing-edge flowfields p 615 A91-37420
Composites for a widebody p 612 A91-39852
Static measurements of slender delta wing rolling moment hysteresis p 625 A91-40223
An experimental investigation of vortex pair interaction with a clean or contaminated free surface p 680 N91-23419

TRAJECTORY ANALYSIS
A vortex panel method for calculating aircraft downwash on parachute trajectories
[DE91-009764] p 627 N91-23085

TRAJECTORY CONTROL
Integration of four-dimensional guidance with total energy control system --- integrated autopilot/autothrottle control system design p 665 A91-39410

TRAJECTORY MEASUREMENT
Evaluation of the phase distortions of the input signal of a synthetic-aperture radar p 677 A91-39144

TRAJECTORY OPTIMIZATION
Navigation, guidance, and trajectory optimization for hypersonic vehicles p 644 N91-23150
Trajectory optimization considerations for ramjet engines p 658 N91-23151

TRANSATMOSPHERIC VEHICLES
Airbreathing propulsion for transatmospheric flight p 659 N91-23156

TRANSFER FUNCTIONS
Lateral-direction tracking requirements from simulation data p 686 A91-39436

TRANSIENT RESPONSE
The transient dynamic performances of a rotor-SFDB system during passage through resonance p 678 A91-40130
Feasibility study in crack detection in aircraft stiffened panels by pulse probing and deconvolution p 654 N91-24158

TRANSITION FLIGHT
Variable Sweep Transition Flight Experiment (VSTFE): Unified Stability System (USS). Description and users' manual
[NASA-CR-181918] p 634 N91-24139

TRANSITION FLOW
Experiments on swept-wing boundary layers p 622 A91-39932
Instability features appearing on swept wing configurations p 622 A91-39937

TRANSONIC COMPRESSORS
Viscous design and analysis methods for transonic compressor blading
[AD-A232902] p 682 N91-24530

TRANSONIC FLOW
Subsonic and supersonic combustion using noncircular injectors p 674 A91-37414
Interactive three-dimensional boundary-layer method for transonic flow over swept wings p 616 A91-37829
Cell centered and cell vertex multigrid schemes for the Navier-Stokes equations p 674 A91-37834
Three-dimensional composite velocity solutions for subsonic/transonic flow p 616 A91-37841
Calculation of steady and unsteady pressures on wings at supersonic speeds with a transonic small-disturbance code p 617 A91-38544
Acoustics of unsteady transonic flow p 687 A91-38688
Steady linearised aerodynamics. III - Transonic p 620 A91-39223
Aerodynamics at the speed of sound p 621 A91-39900
Transonic analysis and design using an improved grid p 624 A91-40137
A new pseudo-potential function model for rotational flow and its application to transonic-supersonic flow p 625 A91-40373
Computation of three-dimensional flow fields through compressor blade rows p 625 A91-40375
Fluid dynamics for the study of transonic flow --- Book p 625 A91-40513
Euler calculations of unsteady transonic flow in cascades
[AIAA PAPER 91-1104] p 626 A91-40562
A study of the noise mechanisms of transonic blade-vortex interactions
[NASA-CR-188199] p 627 N91-23084
Block implicit multigrid solution of the Euler equations p 680 N91-23413
The propagation of acoustic disturbances in the transonic flow fields of wings
[ESA-TT-1126] p 689 N91-23854
Euler flow predictions for an oscillating cascade using a high resolution wave-split scheme
[NASA-TM-104377] p 630 N91-24107
Transonic Symposium: Theory, Application and Experiment, volume 2
[NASA-CP-3020-VOL-2] p 634 N91-24132
Laminar-flow wind tunnel experiments p 634 N91-24136

TRANSONIC FLUTTER
Transonic flutter analysis of 2-D airfoils with 2 degrees of freedom p 665 A91-40169
The propagation of acoustic disturbances in the transonic flow fields of wings
[ESA-TT-1126] p 689 N91-23854

TRANSONIC NOZZLES
Aero-thermal investigation of a highly loaded transonic linear turbine guide vane cascade. A test case for inviscid and viscous flow computations
[VKI-TN-174] p 680 N91-23437

TRANSONIC SPEED
The breakdown of the linearized theory and the role of quadrupole sources in transonic rotor acoustics p 688 A91-39749
An initial investigation into methods of computing transonic aerodynamic sensitivity coefficients
[NASA-CR-188192] p 629 N91-24099

TRANSONIC WIND TUNNELS
National Transonic Facility status p 669 N91-24133
Reynolds number effects on the transonic aerodynamics of a slender wing-body configuration p 634 N91-24134

TRANSPORT AIRCRAFT
Aeronautical research in the United States - Challenges for the 1990's p 612 A91-38580
Composites for a widebody p 612 A91-39852
Handling qualities guidelines for the design of fly-by-wire flight control systems for transport aircraft p 667 N91-23119
Observatory of new materials. Evolution perspectives for the materials used in civil transportation aircraft
[REPT-911-111-107] p 672 N91-23248
Developing and utilizing an Euler computational method for predicting the airframe/propulsion effects for an aft-mounted turboprop transport. Volume 1: Theory document
[NASA-CR-181924-VOL-1] p 632 N91-24118
Developing and utilizing an Euler computational method for predicting the airframe/propulsion effects for an aft-mounted turboprop transport. Volume 2: User guide
[NASA-CR-181924-VOL-2] p 632 N91-24119

TRANSPORT PROPERTIES
Real gas effects on hypersonic boundary-layer stability p 614 A91-36453

TRENDS
Fighter escape system - The next step forward p 646 A91-39382

TUNING
Mechanical component diagnostic system
[AD-A232126] p 656 N91-23146

TURBINE BLADES
Unsteady pressure fluctuation on a highly loaded turbine blade row p 619 A91-38702
Water-cooling technique of high temperature gas turbine blade
[DE91-764238] p 681 N91-23506
Coolant side heat transfer with rotation. Task 3 report: Application of computational fluid dynamics
[NASA-CR-182109] p 683 N91-24551

TURBINE ENGINES
Titanium aluminides for aerospace applications p 671 A91-39302
Multi-heat addition turbine engine
[NASA-CASE-LEW-15094-1] p 660 N91-23180
A new facility to study three dimensional viscous flow and rotor-stator interaction in turbines p 682 N91-24336

TURBINE WHEELS
A new facility to study three dimensional viscous flow and rotor-stator interaction in turbines p 682 N91-24336
Average-passage flow model development p 682 N91-24338

TURBOCOMPRESSORS
Temporally and spatially resolved flow in a two-stage axial compressor. II - Computational assessment
[ASME PAPER 90-GT-299] p 620 A91-39048

TURBOFAN ENGINES
Cycle analysis for a supersonic through flow fan engine p 657 A91-38207
NASA aeropropulsion research in support of propulsion systems of the 21st century
[NASA-TM-104403] p 627 N91-23083
Small Engine Component Technology (SECT) studies
[NASA-CR-175080] p 663 N91-24206
Small Engine Component Technology (SECT) study
[NASA-CR-175079] p 663 N91-24208

TURBOJET ENGINES
Comparative study of different systems of combined cycle propulsion p 658 N91-23152
Turbojet potential for hypersonic flight p 658 N91-23155
Small Engine Component Technology (SECT)
[NASA-CR-175078] p 662 N91-24205
Model 320-2: A compact advanced UAV turbojet p 663 N91-24292

TURBOMACHINERY
Design and development of aviation gas turbine engines --- Russian book p 657 A91-39201

TURBOPROP AIRCRAFT
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 2: Development of theory for wing shielding
[NASA-CR-185192] p 688 N91-23849
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 3: Application of theory for blade loading, wakes, noise, and wing shielding
[NASA-CR-185193] p 688 N91-23850
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 4: Computer user's manual for UAAP turboprop aeroacoustic code
[NASA-CR-185194] p 688 N91-23851
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 5: Propagation of propeller tone noise through a fuselage boundary layer
[NASA-CR-185195] p 689 N91-23852
Developing and utilizing an Euler computational method for predicting the airframe/propulsion effects for an aft-mounted turboprop transport. Volume 1: Theory document
[NASA-CR-181924-VOL-1] p 632 N91-24118
Developing and utilizing an Euler computational method for predicting the airframe/propulsion effects for an aft-mounted turboprop transport. Volume 2: User guide
[NASA-CR-181924-VOL-2] p 632 N91-24119
TURBOPROP ENGINES
Small Engine Component Technology (SECT) study. Program report
[NASA-CR-175077] p 662 N91-24204
TURBORAMJET ENGINES
Comparative study of different systems of combined cycle propulsion p 658 N91-23152
TURBOROCKET ENGINES
Comparative study of different systems of combined cycle propulsion p 658 N91-23152
TURBULENCE
Status of turbulence Prediction System's AWAS 3 p 637 N91-24146
TURBULENCE MODELS
Three-dimensional finite element method analysis of turbulent flow over self-propelled slender bodies p 615 A91-37419
Airfoil design method using the Navier-Stokes equations p 646 A91-38550
Numerical study of twin-jet impingement upwash flow p 619 A91-38736
Advanced computational models for analyzing high speed propulsive flowfields p 686 N91-24291
Average-passage flow model development p 682 N91-24338
TURBULENT BOUNDARY LAYER
Unsteady wave structure near separation in a Mach 5 compression ramp interaction p 616 A91-37838
Inception length to a fully developed, fin-generated, shock-wave, boundary-layer interaction p 617 A91-37842
The effect of streamwise vortices on a turbulent boundary layer exposed to an unsteady adverse pressure gradient p 675 A91-38693
Steady flow in a three-dimensional rectangular cavity yawed from the freestream turbulent boundary layer p 619 A91-38742
A model for the experimental study of curvature effects on transition of the boundary layer on a swept wing - Preliminary results p 620 A91-39691
Receptivity and stability of the boundary layer at a high turbulence level p 678 A91-39945
An experimental study of an axisymmetric turbulent boundary layer disturbed by a periodic freestream p 626 N91-23078
A study of three dimensional turbulent boundary layer separation and vortex flow control using the reduced Navier Stokes equations
[NASA-TM-104407] p 628 N91-23089
The 3-D Navier-Stokes analysis of crossing, glancing shocks/turbulent boundary layer interactions
[NASA-TM-104469] p 633 N91-24130
Results of correlations for transition location on a clean-up glove installed on an F-14 aircraft and design studies for a laminar glove for the X-29 aircraft accounting for spanwise pressure gradient p 654 N91-24138
TURBULENT FLOW
Three-dimensional finite element method analysis of turbulent flow over self-propelled slender bodies p 615 A91-37419
Structure of the compressible turbulent shear layer p 616 A91-37830
Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Ecole Nationale Superieure de l'Aeronautique et de l'Espace, Toulouse, France, Sept. 11-15, 1989 p 677 A91-39901
On the development of turbulent spots in plane Poiseuille flow p 678 A91-39904
Investigations on flow instabilities on airfoils by means of piezofoil-arrays p 621 A91-39911
An experimental study of an axisymmetric turbulent boundary layer disturbed by a periodic freestream p 626 N91-23078
Theoretical and experimental performance of a solid fuel ramjet combustion cycle for hypersonic flight conditions p 660 N91-23170
Implicit solvers for unstructured meshes
[NASA-CR-187564] p 633 N91-24125
TWO DIMENSIONAL BODIES
Transonic flutter analysis of 2-D airfoils with 2 degrees of freedom p 665 A91-40169
TWO DIMENSIONAL FLOW
The stability to two-dimensional wakes and shear layers at high Mach numbers p 614 A91-36452
On the improvement of the supersonic lifting line theory p 614 A91-36695
Numerical investigation of airfoil/jet/fuselage-undersurface flowfields in ground effect p 617 A91-38541
On some physical aspects of airfoil dynamic stall p 618 A91-38686
Application of vortex dynamics to simulations of two-dimensional wakes p 676 A91-38706
Secondary frequencies in the wake of a circular cylinder with vortex shedding p 620 A91-39736
Further experiments on vortex formation around an oscillating and translating airfoil at large incidences p 620 A91-39738
Boundary layer control by a local heating of the wall p 678 A91-39909
Second mode interactions in supersonic boundary layers p 623 A91-39957
The 2-D supersonic nozzle design p 660 N91-23176
TWO DIMENSIONAL MODELS
Moving surface boundary-layer control as applied to two-dimensional airfoils p 615 A91-37768
TWO PHASE FLOW
Status of heavy rain tests p 640 N91-24180

U

ULTRAHIGH FREQUENCIES
RADAR performance experiments p 639 N91-24168
SATURN: The next generation radio for NATO p 682 N91-24475
UNIFORM FLOW
Rotary oscillation control of a cylinder wake p 620 A91-39708
UNSTEADY AERODYNAMICS
Stability of hingeless rotors in hover using three-dimensional unsteady aerodynamics p 663 A91-36358
Unsteady, frequency-domain analysis of helicopter non-rotating lifting surfaces p 613 A91-36359
Simplification of nonlinear indicial response models - Assessment for the two-dimensional airfoil case p 664 A91-37771
Asymmetric vortices on a slender body of revolution p 616 A91-37827
Unsteady wave structure near separation in a Mach 5 compression ramp interaction p 616 A91-37838
Forebody vortex control with the unsteady bleed technique p 617 A91-37859
Calculation of steady and unsteady pressures on wings at supersonic speeds with a transonic small-disturbance code p 617 A91-38544
Unsteady flow past an airfoil pitched at constant rate p 617 A91-38679
Unsteady aerodynamic loading of delta wings for low and high angles of attack p 617 A91-38680
Computation of axisymmetric slender bodies enclosing a jet efflux in pitching oscillatory motion p 618 A91-38681
Numerical simulation of steady and unsteady asymmetric vortical flow p 618 A91-38683
Visualization of the flow about a delta wing maneuvering in pitch to very high angle of attack p 618 A91-38684
On some physical aspects of airfoil dynamic stall p 618 A91-38686
Unsteady separation on an impulsively set into motion Carafoli airfoil p 618 A91-38694
A new system for unsteady aerodynamics of moving wall p 618 A91-38695
Deep stall of an NACA 0012 airfoil induced by periodic aerodynamic interference p 619 A91-38699
Unsteady pressure fluctuation on a highly loaded turbine blade row p 619 A91-38702
Temporally and spatially resolved flow in a two-stage axial compressor. II - Computational assessment
[ASME PAPER 90-GT-299] p 620 A91-39048
Flow around an unsteady thin wing close to curved ground p 620 A91-39744
Aerodynamics at the speed of sound p 621 A91-39900
Experiments on the unsteadiness associated with a ground vortex p 624 A91-40220
Modeling for unsteady aerodynamics of rectangular wing in incompressible flow using step responses p 625 A91-40473
The propagation of acoustic disturbances in the transonic flow fields of wings
[ESA-TT-1126] p 689 N91-23854
Aerodynamic interactions between bodies in relative motion p 629 N91-24103
UNSTEADY FLOW
Unsteady flow past an airfoil pitched at constant rate p 617 A91-38679
Numerical simulation of steady and unsteady asymmetric vortical flow p 618 A91-38683
Acoustics of unsteady transonic flow p 687 A91-38688
The effect of streamwise vortices on a turbulent boundary layer exposed to an unsteady adverse pressure gradient p 675 A91-38693
Unsteady separation on an impulsively set into motion Carafoli airfoil p 618 A91-38694
Analysis and control of low-speed forced unsteady flow p 676 A91-38697
Unsteady pressure fluctuation on a highly loaded turbine blade row p 619 A91-38702
Quantitative analysis of flow visualizations in ONERA water tunnels p 677 A91-39694
Secondary frequencies in the wake of a circular cylinder with vortex shedding p 620 A91-39736
Instability features appearing on swept wing configurations p 622 A91-39937
Fluid dynamics for the study of transonic flow --- Book p 625 A91-40513
Euler calculations of unsteady transonic flow in cascades
[AIAA PAPER 91-1104] p 626 A91-40562
Unsteady flow structure from swept edges subjected to controlled motion
[AD-A232714] p 628 N91-23094
Aerodynamic interactions between bodies in relative motion p 629 N91-24103
Euler flow predictions for an oscillating cascade using a high resolution wave-split scheme
[NASA-TM-104377] p 630 N91-24107
Unsteady Navier-Stokes solutions for a low aspect ratio delta wing
[AD-A233201] p 631 N91-24112
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 3: Unsteady
[AD-A233569] p 631 N91-24115
UNSWEPT WINGS
Asymptotic theory of bending-torsion flutter of high aspect ratio wing in the torsion controlled domain p 675 A91-37846
UPWASH
Numerical study of twin-jet impingement upwash flow p 619 A91-38736
USER MANUALS (COMPUTER PROGRAMS)
Aerodynamic preliminary analysis system 2. Part 2: User's manual
[NASA-CR-182077] p 627 N91-23081
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 4: Computer user's manual for UAAP turboprop aeroacoustic code
[NASA-CR-185194] p 688 N91-23851
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 2: User manual for VORSTAB-2
[AD-A233483] p 631 N91-24114
Developing and utilizing an Euler computational method for predicting the airframe/propulsion effects for an aft-mounted turboprop transport. Volume 2: User guide
[NASA-CR-181924-VOL-2] p 632 N91-24119
A general multiblock Euler code for propulsion integration. Volume 2: User guide for BCON, pre-processor for grid generation and GMBE
[NASA-CR-187484-VOL-2] p 632 N91-24121
A general multiblock Euler code for propulsion integration. Volume 3: User guide for the Euler code
[NASA-CR-187484-VOL-3] p 632 N91-24122
ALDAS user's manual
[NASA-TM-102831] p 687 N91-24757

V

V-22 AIRCRAFT
Tiltrotor developments p 612 A91-40180
Testing the tiltrotor flight control system p 666 A91-40202
V/STOL AIRCRAFT
AGARD highlights 91/1, March 1991
[AGARD-HIGHLIGHTS-91/1] p 691 N91-24084

Suckdown, fountain lift, and pressures induced on several tandem jet V/STOL configurations
[NASA-TM-102817] p 630 N91-24108
Theoretical evaluation of engine auxiliary inlet design for supersonic V/STOL aircraft
[NASA-CR-187098] p 633 N91-24123
Static performance tests of a flight-type STOVL ejector
[NASA-TM-104437] p 662 N91-24201

VAPORIZING
Fuel-rich, catalytic reaction experimental results
[NASA-TM-104423] p 662 N91-24203

VARIABLE SWEEP WINGS
A320 - First of the computer-age aircraft
p 645 A91-36354
Aerodynamic characteristics of scissor-wing geometries p 624 A91-40216
Effects of wing sweep on in-flight boundary-layer transition for a laminar flow wing at Mach numbers from 0.60 to 0.79
[NASA-TM-101701] p 683 N91-24555
Effects of wing sweep on boundary-layer transition for a smooth F-14A wing at Mach numbers from 0.700 to 0.825
[NASA-TM-101712] p 683 N91-24556

VELOCITY DISTRIBUTION
Viscous three-dimensional analyses for nozzles for hypersonic propulsion p 629 N91-23175
Effects of inlet distortion on the development of secondary flows in a subsonic axial inlet compressor rotor
[NASA-TM-104356] p 660 N91-23179

VELOCITY MEASUREMENT
Velocity sensor for an airborne optical air data system
p 655 A91-38542

VERTICAL LANDING
Static performance tests of a flight-type STOVL ejector
[NASA-TM-104437] p 662 N91-24201

VERTICAL TAKEOFF AIRCRAFT
Numerical investigation of airfoil/jet/fuselage-undersurface flowfields in ground effect p 617 A91-38541
Tiltrotor developments p 612 A91-40180

VIBRATION
Modal analysis of multistage gear systems coupled with gearbox vibrations
[NASA-TM-103797] p 681 N91-23513

VIBRATION DAMPING
ACT wind-tunnel experiments of a transport-type wing
p 615 A91-37772
The control of rotor vibration using squeeze-film dampers p 677 A91-39590

VIBRATION TESTS
Similarities and differences between environment tests and reliability tests in view of vibration
p 665 A91-40166
Application of identification method of modal parameters to flight flutter test p 665 A91-40167
Integration of vibration test and flutter analysis - A brief introduction to 'a real-time flutter analysis system'
p 665 A91-40168
Identification of nacelle modes from airplane GVT results p 648 A91-40170
Flexure vibration test method of aviation tube
p 648 A91-40172
Prediction of test spectrum for gunfire vibration
p 666 A91-40175
Vibration behavior of a labyrinth seal with through-flow
p 679 A91-40241

VIDEO TAPES
An overview of information resources in aviation
p 690 N91-24091

VISCOUS FLOW
Discontinuous solutions for a three-dimensional hypersonic boundary layer with interaction
p 614 A91-37176
Fluid dynamics for the study of transonic flow --- Book
p 625 A91-40513
A study of the noise mechanisms of transonic blade-vortex interactions
[NASA-CR-188199] p 627 N91-23084
Some aspects of shock-wave boundary layer interaction relevant to intake flows p 628 N91-23161
Viscous three-dimensional analyses for nozzles for hypersonic propulsion p 629 N91-23175
The 3-D Navier-Stokes analysis of crossing, glancing shocks/turbulent boundary layer interactions
[NASA-TM-104469] p 633 N91-24130
Average-passage flow model development
p 682 N91-24338
Viscous design and analysis methods for transonic compressor blading
[AD-A232902] p 682 N91-24530
Simulation of the flow past an impulsively started cylinder using a discrete vortex method
[AD-A233066] p 683 N91-24533

VISIBILITY
Air ambulance helicopter operational analysis
[DOT/FAA/RD-91/7] p 652 N91-23134

VISUAL FLIGHT RULES
Air ambulance helicopter operational analysis
[DOT/FAA/RD-91/7] p 652 N91-23134

VOICE COMMUNICATION
SATURN: The next generation radio for NATO
p 682 N91-24475

VORTEX ALLEVIATION
The computation of induced drag with nonplanar and deformed wakes p 630 N91-24106

VORTEX BREAKDOWN
Breaking down the delta wing vortex: The role of vorticity in the breakdown process
[NASA-CR-188235] p 630 N91-24109
An experimental analysis of critical factors involved in the breakdown process of leading edge vortex flows
[NASA-CR-188231] p 631 N91-24110

VORTEX FILAMENTS
A vortex panel method for calculating aircraft downwash on parachute trajectories
[DE91-009764] p 627 N91-23085
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 2: User manual for VORSTAB-2
[AD-A233483] p 631 N91-24114

VORTEX FLAPS
The performance of 60 deg delta wings: The effects of leading edge radius on vortex flaps and the wing
[CRANFIELD-AERO-9004] p 628 N91-23092
The performance of 60 deg delta wings: The effects of leading edge radius and vortex flaps
[CRANFIELD-AERO-9002] p 653 N91-23140

VORTEX GENERATORS
Application of vortex dynamics to simulations of two-dimensional wakes p 676 A91-38706
The effects of controlling vortex formation on the performance of a dump combustor p 672 N91-23270
An experimental investigation of vortex pair interaction with a clean or contaminated free surface
p 680 N91-23419
A design strategy for the use of vortex generators to manage inlet-engine distortion using computational fluid dynamics
[NASA-TM-104436] p 633 N91-24131

VORTEX SHEDDING
Asymmetric vortices on a slender body of revolution
p 616 A91-37827
Forebody vortex control with the unsteady bleed technique p 617 A91-37859
Vortex shedding and lock-on in bluff body wakes
p 675 A91-38689
Rotary oscillation control of a cylinder wake
p 620 A91-39708
Secondary frequencies in the wake of a circular cylinder with vortex shedding p 620 A91-39736
The effects of controlling vortex formation on the performance of a dump combustor p 672 N91-23270

VORTEX SHEETS
Simulation of the flow past an impulsively started cylinder using a discrete vortex method
[AD-A233066] p 683 N91-24533

VORTICES
Forebody vortex control with the unsteady bleed technique p 617 A91-37859
Numerical simulation of steady and unsteady asymmetric vortical flow p 618 A91-38683
The effect of streamwise vortices on a turbulent boundary layer exposed to an unsteady adverse pressure gradient p 675 A91-38693
Theoretical study of Goertler vortices - Linear stability approach p 623 A91-39950
Synchronous iterative method for computation of vortex flows at high angles of attack p 624 A91-40126
Experiments on the unsteadiness associated with a ground vortex p 624 A91-40220
Aircraft wake vortices: An assessment of the current situation
[AD-A231658] p 626 N91-23079
A study of the noise mechanisms of transonic blade-vortex interactions
[NASA-CR-188199] p 627 N91-23084
A vortex panel method for calculating aircraft downwash on parachute trajectories
[DE91-009764] p 627 N91-23085
A study of three dimensional turbulent boundary layer separation and vortex flow control using the reduced Navier Stokes equations
[NASA-TM-104407] p 628 N91-23089
The effects of controlling vortex formation on the performance of a dump combustor p 672 N91-23270
An experimental investigation of vortex pair interaction with a clean or contaminated free surface
p 680 N91-23419
An efficient hybrid scheme for the solution of rotational flow around advanced propellers p 629 N91-24104
Breaking down the delta wing vortex: The role of vorticity in the breakdown process
[NASA-CR-188235] p 630 N91-24109
An experimental analysis of critical factors involved in the breakdown process of leading edge vortex flows
[NASA-CR-188231] p 631 N91-24110
Aircraft wake vortices: An annotated bibliography (1923-1990)
[AD-A233161] p 631 N91-24111
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 2: User manual for VORSTAB-2
[AD-A233483] p 631 N91-24114
MEGASODAR experiment p 639 N91-24169
Simulation of the flow past an impulsively started cylinder using a discrete vortex method
[AD-A233066] p 683 N91-24533

VORTICITY
Wing calculation in supersonic flow by means of the supersonic lifting line theory p 614 A91-36700
On the Goertler vortex instability mechanism at hypersonic speeds p 623 A91-39940
The effects of controlling vortex formation on the performance of a dump combustor p 672 N91-23270
Passive laminar flow control of crossflow vorticity
[NASA-CASE-LAR-13563-1] p 679 N91-23410
Simulation of the flow past an impulsively started cylinder using a discrete vortex method
[AD-A233066] p 683 N91-24533

VORTICITY EQUATIONS
Optimization of rotor performance in hover using a free wake analysis p 646 A91-38548

W

WAKES
Secondary frequencies in the wake of a circular cylinder with vortex shedding p 620 A91-39736
Aerodynamics and stabilization of combustion of hydrogen jets injected into subsonic airflow
p 629 N91-23164
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 3: Application of theory for blade loading, wakes, noise, and wing shielding
[NASA-CR-185193] p 688 N91-23850
MEGASODAR experiment p 639 N91-24169

WALL FLOW
A new system for unsteady aerodynamics of moving wall p 618 A91-38695
On the Goertler vortex instability mechanism at hypersonic speeds p 623 A91-39940

WALL PRESSURE
Unsteady wave structure near separation in a Mach 5 compression ramp interaction p 616 A91-37838
Procedure for determination of three-dimensional wind tunnel wall interferences and wall adaptation in compressible subsonic flow using measured wall pressures
[DLR-FB-90-46] p 628 N91-23088

WARNING SYSTEMS
Aircraft Command in Emergency Situations (ACES). Phase 1: Concept development
[DOT/FAA/CT-90/21] p 636 N91-23097
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 2
[NASA-CP-10060-PT-2] p 636 N91-24140
CLASS: Coherent Lidar Airborne Shear Sensor. Windshear avoidance
[LMSC-F-415048] p 636 N91-24141
Continuous wave laser for wind shear detection
p 637 N91-24142
Status of 2 micron laser technology program
p 637 N91-24143
Avionic laser multisensor program at Litton Aero Products p 637 N91-24144
Status of NASA's IR wind shear detection research
p 637 N91-24145
Status of turbulence Prediction System's AWAS 3
p 637 N91-24146
An airborne FLIR detection and warning system for low altitude wind shear p 637 N91-24147
Wind Shear radar program future plans
p 637 N91-24151
Radar simulation program upgrade and algorithm development p 638 N91-24153
Signal processing techniques for clutter filtering and wind shear detection p 638 N91-24154
Airborne radar simulation studies of the Denver July 11, 1988 microburst p 638 N91-24155

Description, characteristics and testing of the NASA airborne radar p 638 N91-24156
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 1
[NASA-CP-10060-PT-1] p 639 N91-24166
Microburst avoidance simulation tests p 639 N91-24172
TDWR information on the flight deck p 640 N91-24176
Integration of the TDWR and LLWAS wind shear detection system p 640 N91-24178
Thermodynamic Alerter for Microbursts (TAMP) p 640 N91-24179
Status of Sundstrand research p 640 N91-24183

WATER
The LWC parameter - Some experimental results --- liquid water content in atmosphere p 685 A91-38388
Water droplet impingement on airfoils and aircraft engine inlets for icing analysis p 634 A91-38543

WAVE PROPAGATION
The propagation of acoustic disturbances in the transonic flow fields of wings
[ESA-TT-1126] p 689 N91-23854

WAVERIDERS
Hypersonic aerodynamics fellowships
[AD-A233584] p 632 N91-24116

WEAR TESTS
Advanced thermally stable jet fuels development program annual report. Volume 3: Fuel lubricity
[AD-A232793] p 673 N91-24453

WEATHER
Radiation transmission in adverse weather p 675 A91-37880
Air ambulance helicopter operational analysis
[DOT/FAA/RD-91/7] p 652 N91-23134

WEATHER FORECASTING
Integration of weather sensing devices p 639 N91-24174

WEBS (SUPPORTS)
Nonlinear analysis of composite shear webs with holes and correlation with tests p 684 N91-24642

WEDGE FLOW
Variable-property effects in supersonic wedge flow p 616 A91-37832
On the instability of hypersonic flow past a wedge p 621 A91-39922

WINCHES
Airborne rescue system
[NASA-CASE-ARC-11909-1] p 635 N91-23095

WIND PROFILES
Analysis of numerical solutions for three-dimensional lifting wing flows p 625 A91-40498

WIND SHEAR
Clutter rejection in Doppler weather radars used for airport wind shear detection p 685 A91-37104
Coherent lidar airborne windshear sensor - Performance evaluation p 655 A91-39873
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 2
[NASA-CP-10060-PT-2] p 636 N91-24140
CLASS: Coherent Lidar Airborne Shear Sensor. Windshear avoidance
[LMSC-F-415048] p 636 N91-24141
Continuous wave laser for wind shear detection p 637 N91-24142
Status of 2 micron laser technology program p 637 N91-24143
Avionic laser multisensor program at Litton Aero Products p 637 N91-24144
Status of NASA's IR wind shear detection research p 637 N91-24145
Status of turbulence Prediction System's AWAS 3 p 637 N91-24146
An airborne FLIR detection and warning system for low altitude wind shear p 637 N91-24147
Saberliner flight test for airborne wind shear forward looking detection and avoidance radar systems p 637 N91-24149
Wind Shear radar program future plans p 637 N91-24151
Clutter modeling of the Denver Airport and surrounding areas p 638 N91-24152
Signal processing techniques for clutter filtering and wind shear detection p 638 N91-24154
Airborne radar simulation studies of the Denver July 11, 1988 microburst p 638 N91-24155
Description, characteristics and testing of the NASA airborne radar p 638 N91-24156
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 1
[NASA-CP-10060-PT-1] p 639 N91-24166
LIDAR studies on microbursts p 639 N91-24167
RADAR performance experiments p 639 N91-24168
MEGASODAR experiment p 639 N91-24169
Microburst avoidance simulation tests p 639 N91-24172
Wind shear training applications for 91/135 p 639 N91-24173
NASA Langley flight test program p 639 N91-24175
TDWR information on the flight deck p 640 N91-24176
Orlando experiment p 640 N91-24177
Integration of the TDWR and LLWAS wind shear detection system p 640 N91-24178
Thermodynamic Alerter for Microbursts (TAMP) p 640 N91-24179
Status of Sundstrand research p 640 N91-24183
Temperature lapse rate as an adjunct to wind shear detection p 640 N91-24184

WIND TUNNEL NOZZLES
An isentropic compression-heated Ludweig tube transient wind tunnel p 673 A91-36450

WIND TUNNEL TESTS
Mach 4 testing of scramjet inlet models p 615 A91-37418
Experimental investigation of loading effects on compressor trailing-edge flowfields p 615 A91-37420
ACT wind-tunnel experiments of a transport-type wing p 615 A91-37772
A comparison between computation and experiment for flows around airfoil with slat and flap p 616 A91-37780
Structure of the compressible turbulent shear layer p 616 A91-37830
Forebody vortex control with the unsteady bleed technique p 617 A91-37859
High subsonic flow about a moving spoiler identifying a novel problem of wind tunnel interference p 619 A91-38710
Investigations on flow instabilities on airfoils by means of piezofoil-arrays p 621 A91-39911
Experiments on swept-wing boundary layers p 622 A91-39932
On the stability of swept wing laminar boundary layers including curvature effects p 622 A91-39933
Development and interaction of instabilities in the crossflow field p 622 A91-39938
Aerodynamic characteristics of crescent and elliptic wings at high angles of attack p 624 A91-40219
Effects of canard position on the aerodynamic characteristics of a close-coupled canard configuration at low speed p 649 A91-40495
An introduction to testing parachutes in wind tunnels
[AIAA PAPER 91-0858] p 668 A91-40556
Low Altitude High Speed Cargo Parachute system development - A status report
[AIAA PAPER 91-0880] p 635 A91-40558
Interferometric investigation of supersonic flow fields with shock-shock interactions p 627 N91-23082
The performance of 60 deg delta wings: The effects of leading edge radius on vortex flaps and the wing
[CRANFIELD-AERO-9004] p 628 N91-23092
The performance of 60 deg delta wings: The effects of leading edge radius and vortex flaps
[CRANFIELD-AERO-9002] p 653 N91-23140
A study of supersonic and hypersonic ramjet engines in France from 1950 to 1974 (application on combined cycle aircraft engines) p 658 N91-23149
Transonic Symposium: Theory, Application and Experiment, volume 2
[NASA-CP-3020-VOL-2] p 634 N91-24132
Laminar-flow wind tunnel experiments p 634 N91-24136
Computational support of the X-29A Advanced Technology Demonstrator flight experiment p 653 N91-24137
Status of heavy rain tests p 640 N91-24180

WIND TUNNEL WALLS
Procedure for determination of three-dimensional wind tunnel wall interferences and wall adaptation in compressible subsonic flow using measured wall pressures
[DLR-FB-90-46] p 628 N91-23088

WIND TUNNELS
An isentropic compression-heated Ludweig tube transient wind tunnel p 673 A91-36450

WIND TURBINES
Preference for an inertial degree of freedom describing the teeter motion of windturbine and helicopter rotors p 679 A91-40239

WINDSHIELDS
The nonlinear dynamic response analysis of the front windshield of Y12 under 'bird-impact' loads p 648 A91-40158

WING CAMBER
Flow visualization study of a 1/48-scale AFTI/F111 model to investigate horizontal tail flow disturbances
[NASA-TM-101698] p 633 N91-24128

WING LOADING
Calculation of steady and unsteady pressures on wings at supersonic speeds with a transonic small-disturbance code p 617 A91-38544
Unsteady aerodynamic loading of delta wings for low and high angles of attack p 617 A91-38680
Nonlinear Aerodynamics and the Design of Wing Tips
[NASA-CR-188044] p 630 N91-24105

WING OSCILLATIONS
Asymptotic theory of bending-torsion flutter of high aspect ratio wing in the torsion controlled domain p 675 A91-37846
Euler flow predictions for an oscillating cascade using a high resolution wave-split scheme
[NASA-TM-104377] p 630 N91-24107
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 3: Unsteady
[AD-A233569] p 631 N91-24115

WING PANELS
Study of thermal-expansion-molded, graphite-epoxy hat-stiffened sandwich panels p 675 A91-37845

WING PLANFORMS
Design of aircraft wings subjected to gust loads - A safety index based approach p 675 A91-37851

WING PROFILES
Discontinuous solutions for a three-dimensional hypersonic boundary layer with interaction p 614 A91-37176
Instability features appearing on swept wing configurations p 622 A91-39937
Aerodynamic characteristics of scissor-wing geometries p 624 A91-40216
Analysis of circular elastic membrane wings p 625 A91-40472

WING SLOTS
A comparison between computation and experiment for flows around airfoil with slat and flap p 616 A91-37780

WING TIP VORTICES
Tip vortex/airfoil interaction for a low Reynolds number canard/wing configuration p 617 A91-38545

WING TIPS
Air surveying and data analysis for dynamic response of missiles at swept-back wing tip p 647 A91-40156
Nonlinear Aerodynamics and the Design of Wing Tips
[NASA-CR-188044] p 630 N91-24105

WINGS
On the improvement of the supersonic lifting line theory p 614 A91-36695
Wing calculation in supersonic flow by means of the supersonic lifting line theory p 614 A91-36700
Simulation of iced wing aerodynamics
[NASA-TM-104362] p 628 N91-23086
Application of multidisciplinary optimization methods to the design of a supersonic transport
[NASA-TM-104073] p 652 N91-23135
Integrated multidisciplinary optimization of actively controlled fiber composite wings p 667 N91-23190
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 2: Development of theory for wing shielding
[NASA-CR-185192] p 688 N91-23849
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 3: Application of theory for blade loading, wakes, noise, and wing shielding
[NASA-CR-185193] p 688 N91-23850
The propagation of acoustic disturbances in the transonic flow fields of wings
[ESA-TT-1126] p 689 N91-23854
Variable Sweep Transition Flight Experiment (VSTFE): Unified Stability System (USS). Description and users' manual
[NASA-CR-181918] p 634 N91-24139

WORKLOADS (PSYCHOPHYSIOLOGY)
Methodology for the analytical assessment of aircraft handling qualities p 664 A91-37597
Simulation evaluation of a speed-guidance law for Harrier approach transitions
[NASA-TM-102853] p 668 N91-24209

X

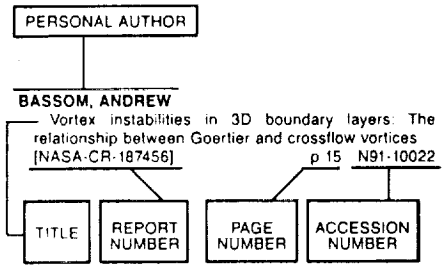
X-29 AIRCRAFT
Flying qualities of the X-29 forward swept wing aircraft p 651 N91-23127
Buffet induced structural/flight-control system interaction of the X-29A aircraft
[NASA-TM-101735] p 652 N91-23133
Computational support of the X-29A Advanced Technology Demonstrator flight experiment p 653 N91-24137

Y

YAG LASERS
Status of 2 micron laser technology program
p 637 N91-24143

YIELD STRENGTH
Improved silicon carbide for advanced heat engines
[NASA-CR-182289] p 672 N91-24451

Typical Personal Author Index Listing



Listings in this index are arranged alphabetically by personal author. The title of the document provides the user with a brief description of the subject matter. The report number helps to indicate the type of document listed (e.g., NASA report, translation, NASA contractor report). The page and accession numbers are located beneath and to the right of the title. Under any one author's name the accession numbers are arranged in sequence.

A

ABARBANEL, SAUL S.
Secondary frequencies in the wake of a circular cylinder with vortex shedding p 620 A91-39736

ACKVA, JOHANNES
Preference for an inertial degree of freedom describing the teeter motion of windturbine and helicopter rotors p 679 A91-40239

ADAMCZYK, JOHN J.
Average-passage flow model development p 682 N91-24338

ADAMSON, PAT
Status of turbulence Prediction System's AWAS 3 p 637 N91-24146

ADELMAN, HENRY G.
Analytical and experimental investigations of the oblique detonation wave engine concept p 660 N91-23169

AHMED, S.
High subsonic flow about a moving spoiler identifying a novel problem of wind tunnel interference p 619 A91-38710

AIBA, TOSHIKI
Track initiation using MHT in dense environments p 674 A91-37141

AL-ZUBAIDY, S. N. J.
Toward automating the design of centrifugal impellers p 676 A91-38874

ALBUGUES, F.
How to know CMC
[REPT-911-430-130] p 672 N91-23262

ALEM, NABIH M.
The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the copilot/gunner, volume 2
[AD-A232907] p 641 N91-24187
The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the copilot/gunner, volume 1
[AD-A233349] p 641 N91-24188

ALFREDSSON, P. H.
On the development of turbulent spots in plane Poiseuille flow p 678 A91-39904

ALMODOVAR, E.
Small Engine Component Technology (SECT) study. Program report
[NASA-CR-175077] p 662 N91-24204

ALSBROOKS, THOMAS H.
Low Altitude High Speed Cargo Parachute system development - A status report
[AIAA PAPER 91-0880] p 635 A91-40558

ALTIZ, O.
Description, characteristics and testing of the NASA airborne radar p 638 N91-24156

AMIET, R. K.
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 2: Development of theory for wing shielding
[NASA-CR-185192] p 688 N91-23849

AMUEDO, KURT C.
Hot gas ingestion test results of a two-poster vectored thrust concept with flow visualization in the NASA Lewis 9- by 15-foot low speed wind tunnel
[AIAA PAPER 90-2268] p 626 A91-40561

AMZAJERDIAN, FARZIN
Avionic laser multisensor program at Litton Aero Products p 637 N91-24144

ANDERMAN, MENAHEM
Prismatic sealed Ni-Cd battery for aircraft power p 657 A91-38178

ANDERSON, B. T.
Correlation of boundary layer stability analysis with flight transition data p 621 A91-39929

ANDERSON, BERNHARD H.
A study of three dimensional turbulent boundary layer separation and vortex flow control using the reduced Navier Stokes equations
[NASA-TM-104407] p 628 N91-23089
A design strategy for the use of vortex generators to manage inlet-engine distortion using computational fluid dynamics
[NASA-TM-104436] p 633 N91-24131

ANDERSON, BIANCA TRUJILLO
Effects of wing sweep on in-flight boundary-layer transition for a laminar flow wing at Mach numbers from 0.60 to 0.79
[NASA-TM-101701] p 683 N91-24555
Effects of wing sweep on boundary-layer transition for a smooth F-14A wing at Mach numbers from 0.700 to 0.825
[NASA-TM-101712] p 683 N91-24556

ANDERSON, CHARLES D.
Aircraft Command in Emergency Situations (ACES). Phase 1: Concept development
[DOT/FAA/CT-90/21] p 636 N91-23097

ANDERSON, E. C.
Real gas effects on hypersonic boundary-layer stability p 614 A91-36453

ANDERSON, JOHN D., JR.
Hypersonic aerodynamics fellowships
[AD-A233584] p 632 N91-24116

ANDO, SHIGENORI
Aerodynamic characteristics of slender wing-gap-body combinations p 615 A91-37777

ANDREI, G.
Airbreathing propulsion for transatmospheric flight p 659 N91-23156

APPLEBY, R. A.
A general multiblock Euler code for propulsion integration. Volume 2: User guide for BCON, pre-processor for grid generation and GMBE
[NASA-CR-187484-VOL-2] p 632 N91-24121

ARBON, ED
Wind shear training applications for 91/135 p 639 N91-24173

ARDAVAN, H.
The breakdown of the linearized theory and the role of quadrupole sources in transonic rotor acoustics p 688 A91-39749

ARNAL, D.
Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Ecole Nationale Superieure de l'Aeronautique et de l'Espace, Toulouse, France, Sept. 11-15, 1989 p 677 A91-39901
Experimental and theoretical analysis of natural transition on 'infinite' swept wing p 621 A91-39927
Theoretical study of Goertler vortices - Linear stability approach p 623 A91-39950
Boundary layer tripping in supersonic flow p 623 A91-39960

ARPASI, DALE J.
Enhancing aeropropulsion research with high-speed interactive computing
[NASA-TM-104374] p 687 N91-24796

ARTS, T.
Aero-thermal investigation of a highly loaded transonic linear turbine guide vane cascade. A test case for inviscid and viscous flow computations
[VKI-TN-174] p 680 N91-23437

ASHLEY, H.
Unsteady aerodynamic loading of delta wings for low and high angles of attack p 617 A91-38680

ASHLEY, STEVEN
Comanche - Tomorrow's high-tech helicopter p 649 A91-40254

ATAMANCHUK, T. M.
Performance characteristics of hypersonic detonation wave ramjets p 659 N91-23168

AURENCHE, Y.
LIDAR studies on microbursts p 639 N91-24167

B

BAE, YOON-YEONG
Performance of an aerospace plane propulsion nozzle p 615 A91-37769

BAHR, BEHNAM
Evaluation of automation for inspection of aging aircraft p 613 N91-24088
Program plans for aviation safety research
[NIAR-90-32] p 638 N91-24157
Feasibility study in crack detection in aircraft stiffened panels by pulse probing and deconvolution p 654 N91-24158
Mechanical paint removal techniques for composite aircraft p 613 N91-24163

BAI, XUESONG
Transonic analysis and design using an improved grid p 624 A91-40137

BAILEY, RANDALL E.
The flying qualities influence of delay in the fighter pilot's cuing environment p 650 N91-23120

BAILLIE, S. W.
An investigation into the use of side-arm control for civil rotorcraft applications p 667 N91-23123
Determination of decision-height windows for decelerating IMC approaches in helicopters p 667 N91-23124

BAIN, KENNETH R.
Modeling of creep-fatigue interaction effects on crack growth p 670 A91-38802

BALSONE, STEPHEN J.
Titanium aluminides for aerospace applications p 671 A91-39302

BALUT, STEPHEN J.
Estimating fixed and variable costs of airframe manufacturers
[AD-A232661] p 613 N91-23077

BANKE, FRED
Aircraft repair/general aviation quick tooling
[SME PAPER EM90-178] p 611 A91-36944

BARANKIEWICZ, WENDY S.
Static performance tests of a flight-type STOVL ejector
[NASA-TM-104437] p 662 N91-24201

BARNETT, MARK
Average-passage flow model development p 682 N91-24338

BARSON, JOHN V.
The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the copilot/gunner, volume 2
[AD-A232907] p 641 N91-24187

The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the copilot/gunner, volume 1
[AD-A233349] p 641 N91-24188

BARTHELEMY, J.-F. M.
Application of multidisciplinary optimization methods to the design of a supersonic transport
[NASA-TM-104073] p 652 N91-23135

BARTHOLOMEW, P.
The role of structural analysis in airworthiness certification p 684 N91-24647

BARTLETT, D. W.
Correlation of boundary layer stability analysis with flight transition data p 621 A91-39929
On the stability of swept wing laminar boundary layers including curvature effects p 622 A91-39933
Laminar-flow flight experiments p 634 N91-24135

BASSANI, MAURIZIO
The LWC parameter - Some experimental results p 685 A91-38388

BATEMAN, DON
Status of Sundstrand research p 640 N91-24183

BATES, B. L.
Computational support of the X-29A Advanced Technology Demonstrator flight experiment p 653 N91-24137

BATINA, JOHN T.
Calculation of steady and unsteady pressures on wings at supersonic speeds with a transonic small-disturbance code p 617 A91-38544

BATTERSON, J. G.
Effects of horizontal tail ice on longitudinal aerodynamic derivatives p 665 A91-38547

BAVA, RENZO
Lateral-direction tracking requirements from simulation data p 686 A91-39436

BAXA, ERNEST G., JR.
Signal processing techniques for clutter filtering and wind shear detection p 638 N91-24154

BEACH, TIM A.
Average-passage flow model development p 682 N91-24338

BECK, J. E.
Airblast atomization at conditions of low air velocity p 674 A91-37410

BECKER, K.-H.
A general method for rotordynamic analysis p 677 A91-39585

BECKER, WAYNE
Program plans for aviation safety research
[NIAR-90-32] p 638 N91-24157
Bonded/fusion repair of aircraft structures p 613 N91-24160
Mechanical paint removal techniques for composite aircraft p 613 N91-24163

BECKWITH, I. E.
Transition research in low-disturbance high-speed wind tunnels p 621 A91-39919

BEHBEHANI, ROXANNA
Variable Sweep Transition Flight Experiment (VSTFE): Unified Stability System (USS). Description and users' manual
[NASA-CR-181918] p 634 N91-24139

BEHNKE, BERND
Vibration behavior of a labyrinth seal with through-flow p 679 A91-40241

BELLAVIA, DAVID C.
Suckdown, fountain lift, and pressures induced on several tandem jet V/STOL configurations
[NASA-TM-102817] p 630 N91-24108

BELLEUDY, J.
A new system for unsteady aerodynamics of moving wall p 618 A91-38695

BEMENT, LAURENCE J.
Helicopter in-flight stores jettison p 671 A91-39389

BENCIC, TIMOTHY J.
Hot gas ingestion test results of a two-poster vectored thrust concept with flow visualization in the NASA Lewis 9- by 15-foot low speed wind tunnel
[AIAA PAPER 90-2268] p 626 A91-40561

BENCZUR-URMOSSY, GABOR
Prismatic sealed Ni-Cd battery for aircraft power p 657 A91-38178

BENDIKSEN, ODDVAR O.
Euler calculations of unsteady transonic flow in cascades
[AIAA PAPER 91-1104] p 626 A91-40562

BENN, K.
Small Engine Component Technology (SECT)
[NASA-CR-175078] p 662 N91-24205

BENNETT, ROBERT M.
Calculation of steady and unsteady pressures on wings at supersonic speeds with a transonic small-disturbance code p 617 A91-38544

BENOIST, ROD
Avionic laser multisensor program at Litton Aero Products p 637 N91-24144

BENSHALOM, URI
Computerized system for static and fatigue large scale structural tests: A case study
[IAITIC-87-1007] p 681 N91-23522

BENSTEIN, ELI H.
Model 320-2: A compact advanced UAV turbojet p 663 N91-24292

BERNHART, WALTER
Program plans for aviation safety research
[NIAR-90-32] p 638 N91-24157

BERNHART, WAYNE
Crashworthiness experiments p 638 N91-24161

BERNIUKOV, A. K.
Functional-adaptive data processing in airborne radio navigation and landing systems p 643 A91-39187

BERTIN, F.
RADAR performance experiments p 639 N91-24168

BERTON, PIERRE
A study of supersonic and hypersonic ramjet engines in France from 1950 to 1974 (application on combined cycle aircraft engines) p 658 N91-23149

BEZOS, GAUDY
Status of heavy rain tests p 640 N91-24180

BIELAWSKI, WILLIAM J.
Environmental exposure effects on composite materials for commercial aircraft
[NASA-CR-187478] p 672 N91-24358

BIEZAD, DANIEL J.
Normalized predictive deconvolution - Multichannel time-series applications to human dynamics p 686 A91-37584

BILLET, M. L.
Experiments on the unsteadiness associated with a ground vortex p 624 A91-40220

BILLIG, F. S.
Design techniques for dual mode ram-scramjet combustors p 659 N91-23166

BIPPES, H.
A model for the experimental study of curvature effects on transition of the boundary layer on a swept wing - Preliminary results p 620 A91-39691
Instability features appearing on swept wing configurations p 622 A91-39937

BJARKE, LISA J.
Flow visualization study of a 1/48-scale AFTI/F111 model to investigate horizontal tail flow disturbances
[NASA-TM-101698] p 633 N91-24128

BLACK, G. THOMAS
MIL-STD-1797 is not a cookbook p 650 N91-23111
Do civil flying qualities requirements address military missions for off-the-shelf procurement p 650 N91-23115

BLAND, SAMUEL R.
Calculation of steady and unsteady pressures on wings at supersonic speeds with a transonic small-disturbance code p 617 A91-38544

BLOM, A. F.
Long time measurements of landing gear loads on SAAB SF-340 commuter aircraft
[FFA-TN-1990-53] p 653 N91-23138

BLUME, H. J. C.
Description, characteristics and testing of the NASA airborne radar p 638 N91-24156

BOBBITT, P. J.
Results of correlations for transition location on a clean-up glove installed on an F-14 aircraft and design studies for a laminar glove for the X-29 aircraft accounting for spanwise pressure gradient p 654 N91-24138

BOGUSLAEV, V. A.
Residual stress control in developing processes for the manufacture of compressor blades for gas turbine engines p 674 A91-37269

BOLES, MICHAEL A.
Theoretical evaluation of engine auxiliary inlet design for supersonic V/STOL aircraft
[NASA-CR-187098] p 633 N91-24123

BOND, T. H.
Effects of horizontal tail ice on longitudinal aerodynamic derivatives p 665 A91-38547

BOND, THOMAS H.
Advanced ice protection systems test in the NASA Lewis icing research tunnel
[NASA-TM-103757] p 661 N91-23183
Model rotor icing tests in the NASA Lewis icing research tunnel
[NASA-TM-104351] p 661 N91-23184

BONHAUS, DARYL L.
Euler analysis of a High-Speed Civil Transport concept at Mach 3 p 624 A91-40217

BONNER, E.
Aerodynamic preliminary analysis system 2. Part 1: Theory
[NASA-CR-182076] p 626 N91-23080

BORIO, U.
Airbreathing propulsion for transatmospheric flight p 659 N91-23156

BOULAY, J. L.
LIDAR studies on microbursts p 639 N91-24167

BOWLES, ROLAND L.
Coherent lidar airborne windshear sensor - Performance evaluation p 655 A91-39873
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 2
[NASA-CP-10060-PT-2] p 636 N91-24140
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 1
[NASA-CP-10060-PT-1] p 639 N91-24166

BOYNTON, J. L.
Unsteady pressure fluctuation on a highly loaded turbine blade row p 619 A91-38702

BRABBS, THEODORE A.
Multi-heat addition turbine engine
[NASA-CASE-LEW-15094-1] p 660 N91-23180

BRACALENTE, E. M.
Airborne radar simulation studies of the Denver July 11, 1988 microburst p 638 N91-24155

BRAGG, M. B.
Simulation of iced wing aerodynamics
[NASA-TM-104362] p 628 N91-23086

BRASLOW, A. L.
Laminar-flow flight experiments p 634 N91-24135

BRAUN, M. J.
Simulation of brush insert for leading-edge-passage convective heat transfer
[NASA-TM-103801] p 679 N91-23409

BREER, MARLIN D.
Water droplet impingement on airfoils and aircraft engine inlets for icing analysis p 634 A91-38543

BRIERE, DOMINIQUE
The electrical flight control system of A320 Airbus: A fault tolerant system
[REPT-911-111-103] p 667 N91-23192

BRIGGS, MARTIN
The English summer of 1990 - Further progress towards deregulation of the aviation and travel industry p 690 A91-37801

BRITT, CHARLES L.
Radar simulation program upgrade and algorithm development p 638 N91-24153
Airborne radar simulation studies of the Denver July 11, 1988 microburst p 638 N91-24155

BRITTON, RANDALL K.
Model rotor icing tests in the NASA Lewis icing research tunnel
[NASA-TM-104351] p 661 N91-23184

BROCKHAUS, R.
A new method for estimating airspeed, attack angle and sideslip angle p 664 A91-37051

BROOKS, CUYLER W., JR.
The NASA Langley laminar-flow-control experiment on a swept, supercritical airfoil: Suction coefficient analysis
[NASA-TM-4267] p 629 N91-24098

BROWN, ALAN S.
Wright Laboratory p 611 A91-36351

BRUCE, W. E., JR.
National Transonic Facility status p 669 N91-24133

BRUDER, JOSEPH A.
Measurement of clutter suppression using a Quadrahedral p 674 A91-37106

BUCHACKER, E.
Development of MIL-8785C into a handling qualities specification for a new European fighter aircraft p 666 N91-23114

BUI, JAMES
Estimating fixed and variable costs of airframe manufacturers
[AD-A232661] p 613 N91-23077

BULLARD, BARRY D.
Pulse Doppler signature of a rotary-wing aircraft p 643 A91-39756

BURGER, C. P.
Designing with composites - A study of design process p 646 A91-38752

BURMEISTER, G. J.
Hardware-in-the-loop testing of the crest ejection seat control system p 647 A91-39394

C

CAI, XIAOBIN
Design and implementation of real-time computer coordinated force actuating system with multi-input/output
[AD-A233114] p 687 N91-24768

CALKINS, ROBERT B.
The Minipac II ejection seat program
p 647 A91-39390
Recent escape system parachute efforts at Douglas Aircraft Company p 635 A91-39393

CALUGI, DAVID
Adaptive airborne track while scan
p 642 A91-37139

CAMBIER, JEAN-LUC
Analytical and experimental investigations of the oblique detonation wave engine concept p 660 N91-23169

CAMCI, C.
A new facility to study three dimensional viscous flow and rotor-stator interaction in turbines
p 682 N91-24336

CAMPBELL, JAMES F.
Interactive three-dimensional boundary-layer method for transonic flow over swept wings p 616 A91-37829

CAMPBELL, STEVE
Orlando experiment p 640 N91-24177

CANACCI, V.
Simulation of brush insert for leading-edge-passage convective heat transfer
[NASA-TM-103801] p 679 N91-23409

CAO, MING
The development and research on CAD for education on aircraft design p 686 A91-38234

CARDABA, A. BARRIO
Nonlinear analysis of composite shear webs with holes and correlation with tests p 684 N91-24642

CARLSON, LELAND A.
An initial investigation into methods of computing transonic aerodynamic sensitivity coefficients
[NASA-CR-188192] p 629 N91-24099

CARTER, CHARLES R.
406 MHz ELT signal spectra for Sarsat
p 643 A91-39778

CASALIS, G.
Experimental and theoretical analysis of natural transition on 'infinite' swept wing p 621 A91-39927

CASE, A. M.
Navigation, guidance, and trajectory optimization for hypersonic vehicles p 644 N91-23150

CASSEM, BRIAN
Model 320-2: A compact advanced UAV turbojet
p 663 N91-24292

CAUGHEY, DAVID A.
Block multigrid implicit solution of the Euler equations of compressible fluid flow p 616 A91-37836

CEBECI, T.
Calculation of low Reynolds number flows at high angles of attack p 624 A91-40218

CEBECI, TUNCER
An evaluation of stability-based methods for transition of three-dimensional flows p 678 A91-39928

CELESTINA, MARK L.
Average-passage flow model development
p 682 N91-24338

CHAMBERS, RANDALL M.
Program plans for aviation safety research
[NIAR-90-32] p 638 N91-24157

CHAMIS, CHRISTOS C.
Probability approach for strength calculations
p 685 N91-24652

CHAMPIGNY, P.
Supersonic-hypersonic inlet studies for aerospaceplane p 659 N91-23160

CHANDLER, RICHARD
Program plans for aviation safety research
[NIAR-90-32] p 638 N91-24157
Crashworthiness experiments p 638 N91-24161

CHEN, C.-G.
Unsteady separation on an impulsively set into motion Carafoli airfoil p 618 A91-38694

CHEN, F.-J.
Transition research in low-disturbance high-speed wind tunnels p 621 A91-39919

CHEN, H. C.
Developing and utilizing an Euler computational method for predicting the airframe/propulsion effects for an aft-mounted turboprop transport. Volume 1: Theory document
[NASA-CR-181924-VOL-1] p 632 N91-24118
Developing and utilizing an Euler computational method for predicting the airframe/propulsion effects for an aft-mounted turboprop transport. Volume 2: User guide
[NASA-CR-181924-VOL-2] p 632 N91-24119
A general multiblock Euler code for propulsion integration. Volume 1: Theory document
[NASA-CR-187484-VOL-1] p 632 N91-24120
A general multiblock Euler code for propulsion integration. Volume 2: User guide for BCON, pre-processor for grid generation and GMBE
[NASA-CR-187484-VOL-2] p 632 N91-24121
A general multiblock Euler code for propulsion integration. Volume 3: User guide for the Euler code
[NASA-CR-187484-VOL-3] p 632 N91-24122

CHEN, H. H.
An evaluation of stability-based methods for transition of three-dimensional flows p 678 A91-39928
Calculation of low Reynolds number flows at high angles of attack p 624 A91-40218

CHEN, S. H.
Unsteady pressure fluctuation on a highly loaded turbine blade row p 619 A91-38702

CHEN, XU
Flexure vibration test method of aviation tube
p 648 A91-40172

CHIN, SUEI
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 1: Steady
[AD-A233482] p 631 N91-24113
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 2: User manual for VORSTAB-2
[AD-A233483] p 631 N91-24114
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 3: Unsteady
[AD-A233569] p 631 N91-24115

CHO, MAENG-HYO
Supersonic flutter analysis of clamped symmetric composite panels using shear deformable finite elements p 675 A91-37847

CHOY, F. K.
Modal analysis of multistage gear systems coupled with gearbox vibrations
[NASA-TM-103797] p 681 N91-23513

CHUBACHI, TATSUO
Re-entry flight control of space plane using approximate perfect servo p 664 A91-37778

CIMBALA, J. M.
Experiments on the unsteadiness associated with a ground vortex p 624 A91-40220

CITURS, KEVIN D.
The handling qualities of the STOL and maneuver technology demonstrator from specification to flight test
p 666 N91-23117

CLARKE, ROBERT
Buffet induced structural/flight-control system interaction of the X-29A aircraft
[NASA-TM-101735] p 652 N91-23133

CLEVER, W.
Aerodynamic preliminary analysis system 2. Part 1: Theory
[NASA-CR-182076] p 626 N91-23080

COBBETT, JOHN A.
Demonstration of a Laser Ordnance Initiation System in an F-16 sled p 646 A91-39377

COEN, P. G.
Application of multidisciplinary optimization methods to the design of a supersonic transport
[NASA-TM-104073] p 652 N91-23135

COLLIER, F.
Blunt-nosed swept supercritical LFC wings without nose flaps p 622 A91-39936

COLLIER, F. S., JR.
Correlation of boundary layer stability analysis with flight transition data p 621 A91-39929
On the stability of swept wing laminar boundary layers including curvature effects p 622 A91-39933
Laminar-flow flight experiments p 634 N91-24135

COLUCCI, FRANK
Composites for a widebody p 612 A91-39852
Moulded Mustang p 612 A91-39854

CORDA, S.
Design techniques for dual mode ram-scramjet combustors p 659 N91-23166

CORNMAN, LARRY
Integration of the TDWR and LLWAS wind shear detection system p 640 N91-24178

CORSIGLIA, VICTOR R.
Suckdown, fountain lift, and pressures induced on several tandem jet V/STOL configurations
[NASA-TM-102817] p 630 N91-24108

COSTIGAN, FRANK
Ejection seat rocket catapult design for reduced G field influence p 646 A91-39385

COUTANCEAU, MADELEINE
Further experiments on vortex formation around an oscillating and translating airfoil at large incidences
p 620 A91-39738

COVERT, E. E.
Deep stall of an NACA 0012 airfoil induced by periodic aerodynamic interference p 619 A91-38699

COWLEY, STEPHEN
On the instability of hypersonic flow past a wedge
p 621 A91-39922

COX, M. E.
European studies to investigate the feasibility of using 1000 ft vertical separation minima above FL 290. I
p 642 A91-38217

CRAWFORD, MARK R.
The handling qualities of the STOL and maneuver technology demonstrator from specification to flight test
p 666 N91-23117

CRIM, G.
NASA-LaRc Flight-Critical Digital Systems Technology Workshop
[NASA-CP-10028] p 655 N91-24200

CRUSE, T. A.
Probability approach for strength calculations
p 685 N91-24652

CUELLAR, JOHN P., JR.
Advanced thermally stable jet fuels development program annual report. Volume 3: Fuel lubricity
[AD-A232793] p 673 N91-24453

CUNDIFF, JEFFREY S.
Reynolds number effects on the transonic aerodynamics of a slender wing-body configuration
p 634 N91-24134

D

DA, REN
A new method for estimating airspeed, attack angle and sideslip angle p 664 A91-37051

DAGENHART, J. R.
Experiments on swept-wing boundary layers
p 622 A91-39932

DAI, GUANZHONG
Design and implementation of real-time computer coordinated force actuating system with multi-input/output
[AD-A233114] p 687 N91-24768

DAILY, JIM
Integration of weather sensing devices
p 639 N91-24174

DAMRON, JOHN
Northrop advanced fighter crew protection system. I - Engineering development. II - System development, test and evaluation p 647 A91-39395

DASH, SANFORD M.
Advanced computational models for analyzing high speed propulsive flowfields p 686 N91-24291

DATTA, P.
Coolant side heat transfer with rotation. Task 3 report: Application of computational fluid dynamics
[NASA-CR-182109] p 683 N91-24551

DAUBE, OLIVIER
Further experiments on vortex formation around an oscillating and translating airfoil at large incidences
p 620 A91-39738

DAVIS, RICHARD E.
Evaluation of cloud detection instruments and performance of laminar-flow leading-edge test articles during NASA Leading-Edge Flight-Test Program
[NASA-TP-2888] p 655 N91-24199

DAWSON, R.
Small Engine Component Technology (SECT)
[NASA-CR-175078] p 662 N91-24205

DEBOER, W. P.
Handling qualities guidelines for the design of fly-by-wire flight control systems for transport aircraft
p 667 N91-23119

DEGANI, D.
Asymmetric vortices on a slender body of revolution
p 616 A91-37827

DEJARNETTE, FRED R.
Interactive three-dimensional boundary-layer method for transonic flow over swept wings p 616 A91-37829

DELILLO, THOMAS K.
Program plans for aviation safety research
[NIAR-90-32] p 638 N91-24157

DELMORE, VICTOR E.
Clutter modeling of the Denver Airport and surrounding areas p 638 N91-24152

DELUCA, D. P.
Fatigue crack growth in monolithic titanium aluminides
p 670 A91-38809

DEMEIS, RICHARD
Long-range aircraft are in demand
p 611 A91-36353

DENNING, R. M.
Aerodynamics at the speed of sound
p 621 A91-39900

DEPETRO, THOMAS G.
An overview of information resources in aviation
p 690 N91-24091

DESHPANDE, MANOHAR D
Signal processing techniques for clutter filtering and wind shear detection p 638 N91-24154

DETLEFSEN, WOLFGANG
Orientation measurements and transmission via Mode S at airports p 643 A91-38526

DIJKSTRA, P.
Theoretical and experimental performance of a solid fuel ramjet combustion cycle for hypersonic flight conditions
p 660 N91-23170

DIMICCO, R. G.
Steady flow in a three-dimensional rectangular cavity yawed from the freestream turbulent boundary layer
p 619 A91-38742

DIMOTAKIS, P. E.
Rotary oscillation control of a cylinder wake
p 620 A91-39708

DINI, PAOLO
A computationally efficient modelling of laminar separation bubbles p 680 N91-23411

DISIMILE, P. J.
Steady flow in a three-dimensional rectangular cavity yawed from the freestream turbulent boundary layer
p 619 A91-38742

DIVAN, P.
Aerodynamic preliminary analysis system 2. Part 2: User's manual
[NASA-CR-182077] p 627 N91-23081

DIXON, PETER G. C.
Soft hub for bearingless rotors
[NASA-CR-177586] p 654 N91-24198

DOERFLER, T.
Investigations on flow instabilities on airfoils by means of piezofoil-arrays p 621 A91-39911

DOLLING, DAVID S.
Unsteady wave structure near separation in a Mach 5 compression ramp interaction p 616 A91-37838

DOLLYHIGH, SAMUEL M.
Euler analysis of a High-Speed Civil Transport concept at Mach 3 p 624 A91-40217

DON, WAI SUN
Secondary frequencies in the wake of a circular cylinder with vortex shedding p 620 A91-39736

DONG, B.
Application of vortex dynamics to simulations of two-dimensional wakes p 676 A91-38706

DONZIER, ALAIN
MEGASODAR experiment p 639 N91-24169

DOUBLIER, MICHEL
Comparative study of different systems of combined cycle propulsion p 658 N91-23152

DOVGAL', A. V.
Boundary layer control by a local heating of the wall
p 678 A91-39909

DOVI, AUGUSTINE R.
Application of multidisciplinary optimization methods to the design of a supersonic transport
[NASA-TM-104073] p 652 N91-23135

DOWDY, PATRICK C.
Pulse Doppler signature of a rotary-wing aircraft
p 643 A91-39756

DRAGOS, L.
New methods in the theory of subsonic flows past thin airfoil configurations p 614 A91-36699

DRELA, MARK
Viscous design and analysis methods for transonic compressor blading
[AD-A232902] p 682 N91-24530

DRING, R. P.
Temporally and spatially resolved flow in a two-stage axial compressor. II - Computational assessment
[ASME PAPER 90-GT-299] p 620 A91-39048

DUNHAM, J. R.
NASA-LaRc Flight-Critical Digital Systems Technology Workshop
[NASA-CP-10028] p 655 N91-24200

DUNN, K.
Aerodynamic preliminary analysis system 2. Part 1: Theory
[NASA-CR-182076] p 626 N91-23080

DUROCHER, CORT
The role of organizations in professional development
p 690 A91-38367

DUVEAU, P.
Supersonic-hypersonic inlet studies for aerospaceplane p 659 N91-23160

DYER, C. S.
Surface activation of Concorde by Be-7
p 690 N91-24983

E

EARLY, M.
Small Engine Component Technology (SECT)
[NASA-CR-175078] p 662 N91-24205

EASTBURG, STEVEN R.
An engineering study of altitude determination deficiencies of the Service Aircraft Instrumentation Package (SAIP)
[AD-A232055] p 656 N91-23145

EASTLAND, A. H.
Unsteady pressure fluctuation on a highly loaded turbine blade row p 619 A91-38702

ECCLES, PETER J.
Thermodynamic Alerter for Microbursts (TAMP)
p 640 N91-24179

EDIRISINGHE, MOHAN J.
Fabrication of engineering ceramics by injection molding p 674 A91-37375

EDWARDS, T. A.
Effect of exhaust plume/afterbody interaction on installed scramjet performance p 615 A91-37770

EICKHOFF, H.
Aerodynamics and stabilization of combustion of hydrogen jets injected into subsonic airflow
p 629 N91-23164

EL-MEHLAWY, F.
Heat transfer in oscillating flows p 676 A91-38698

ELANDS, P. J. M.
Theoretical and experimental performance of a solid fuel ramjet combustion cycle for hypersonic flight conditions
p 660 N91-23170

ELANGOVAN, R.
Water droplet impingement on airfoils and aircraft engine inlets for icing analysis p 634 A91-38543

ELLIOTT, KATHY
Model 320-2: A compact advanced UAV turbojet
p 663 N91-24292

ELLIS, DAVID
Program plans for aviation safety research
[NIAR-90-32] p 638 N91-24157

ELLWOOD, JEFFREY L.
Design and construction of a composite airframe for UAV research
[AD-A232422] p 653 N91-23143

EMANUEL, GEORGE
Performance of an aerospace plane propulsion nozzle
p 615 A91-37769

EMDAD, H.
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 1: Steady
[AD-A233482] p 631 N91-24113
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 2: User manual for VORSTAB-2
[AD-A233483] p 631 N91-24114
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 3: Unsteady
[AD-A233569] p 631 N91-24115

EREMIN, V. V.
Entropy effects of hypersonic flow past blunt delta wings p 615 A91-37181

ERENGIL, MEHMET E.
Unsteady wave structure near separation in a Mach 5 compression ramp interaction p 616 A91-37838

ERLEBACHER, GORDON
Second mode interactions in supersonic boundary layers p 623 A91-39957

ESSMAN, DOUGLAS J.
Turbojet potential for hypersonic flight
p 658 N91-23155

EVANS, JAMES E.
Clutter rejection in Doppler weather radars used for airport wind shear detection p 685 A91-37104

EVANS, R. H.
Lightning protection requirements for aircraft: A proposed specification
[RAE-TM-FS(F)-632-ISSUE-1-R] p 641 N91-24186

EXLEY, T.
Small Engine Component Technology (SECT) study. Program report
[NASA-CR-175077] p 662 N91-24204

F

FADDOUL, F.
Kinetic study of a homogeneous propellant primary flame, with and without additive p 671 A91-39690

FAROKHI, SAEED
A study of three dimensional turbulent boundary layer separation and vortex flow control using the reduced Navier Stokes equations
[NASA-TM-104407] p 628 N91-23089

FAVIER, D.
A new system for unsteady aerodynamics of moving wall p 618 A91-38695

FENG, HAIYAN
Modal analysis for fibre-carbon composite parts of an airplane p 679 A91-40157

FERMAN, M. A.
A new technique and application for nonlinear acoustic fatigue of stiffened composite panels
p 687 A91-38863

FERNANDO, M. S. U. K.
Moving surface boundary-layer control as applied to two-dimensional airfoils p 615 A91-37768

FERRAN, A.
Observatory of new materials. Evolution perspectives for the materials used in civil transportation aircraft
[REPT-911-111-107] p 672 N91-23248

FERRIS, J. C.
Results of correlations for transition location on a clean-up glove installed on an F-14 aircraft and design studies for a laminar glove for the X-29 aircraft accounting for spanwise pressure gradient p 654 N91-24138

FISHBEIN, SAMUEL B.
Flight management systems p 666 A91-40517

FISHER, DAVID F.
Evaluation of cloud detection instruments and performance of laminar-flow leading-edge test articles during NASA Leading-Edge Flight-Test Program
[NASA-TP-2888] p 655 N91-24199

FLATMAN, J. C.
Surface activation of Concorde by Be-7
p 690 N91-24983

FLECKENSTEIN, HUBERT
Air travel - System relating flight safety, aircraft, and airports p 634 A91-38527

FLEMMING, ROBERT J.
Model rotor icing tests in the NASA Lewis icing research tunnel
[NASA-TM-104351] p 661 N91-23184

FLOOD, JOSEPH D.
Hot gas ingestion test results of a two-poster vectored thrust concept with flow visualization in the NASA Lewis 9- by 15-foot low speed wind tunnel
[AIAA PAPER 90-2268] p 626 A91-40561

FORRESTER, D. A.
European studies to investigate the feasibility of using 1000 ft vertical separation minima above FL 290. I
p 642 A91-38217

FOUGHNER, JEROME T., JR.
Transonic Symposium: Theory, Application and Experiment, volume 2
[NASA-CP-3020-VOL-2] p 634 N91-24132

FOX, CHARLES H., JR.
Reynolds number effects on the transonic aerodynamics of a slender wing-body configuration
p 634 N91-24134

FRANC, O.
Oxidation resistant carbon/carbon materials
[REPT-911-430-105] p 672 N91-23251

FRANCISCUS, LEO C.
Multi-heat addition turbine engine
[NASA-CASE-LEW-15094-1] p 660 N91-23180

FRAZIER, THOMAS P.
Estimating fixed and variable costs of airframe manufacturers
[AD-A232661] p 613 N91-23077

FREUND, GEORGE A., JR.
Water droplet impingement on airfoils and aircraft engine inlets for icing analysis p 634 A91-38543

FRITCHMAN, B. M.
Hardware-in-the-loop testing of the crest ejection seat control system p 647 A91-39394

FU, Y. B.
On the Goertler vortex instability mechanism at hypersonic speeds p 623 A91-39940

FULLER, C. R.
Full-scale demonstration tests of cabin noise reduction using active vibration control p 646 A91-38549

FULLERTON, T. L.
A vortex panel method for calculating aircraft downwash on parachute trajectories
[AIAA PAPER 91-0875] p 626 A91-40557
A vortex panel method for calculating aircraft downwash on parachute trajectories
[DE91-009764] p 627 N91-23085

G

GAITA, L.
New developments in the dynamic aeroelastic stability study of rotor blades p 673 A91-36698

GAL-OR, BENJAMIN
Vectored propulsion, supermaneuverability and robot aircraft p 649 A91-40501

GALATI, GASPARE
Evolution of clutter suppression techniques for air traffic control and surveillance radar p 641 A91-37101
GALLEITHNER, H.
Development of MIL-8785C into a handling qualities specification for a new European fighter aircraft p 666 N91-23114
GARCIA, ALAIN
Integration of propulsive systems: Selection and compromise
[REPT-911-111-101] p 661 N91-23187
GARTENBERG, EHUD
Airfoil transition and separation studies using an infrared imaging system p 624 A91-40215
GATINEAU, R. J.
Laboratory test and acoustic analysis of cabin treatment for propfan test assessment aircraft
[NASA-CR-182075] p 690 N91-24844
GAUBLOMME, D. P.
Experiments on the unsteadiness associated with a ground vortex p 624 A91-40220
GAUDET, L.
Visualisation of boundary layer transition p 623 A91-39964
GE, SEN
Calculation and experimental study on sonic fatigue life of aircraft structural panels p 648 A91-40162
GE, YUNQI
Experimental investigation on supersonic combustion p 657 A91-38203
GE, ZUDE
Integration of vibration test and flutter analysis - A brief introduction to 'a real-time flutter analysis system' p 665 A91-40168
GEHSE, HARTMUT
Canopy breaking system for non-delay pilot rescue p 647 A91-39398
GERDES, RONALD M.
Simulation evaluation of a speed-guidance law for Harrier approach transitions
[NASA-TM-102853] p 668 N91-24209
GHIA, K. N.
Analysis and control of low-speed forced unsteady flow p 676 A91-38697
GHIA, U.
Analysis and control of low-speed forced unsteady flow p 676 A91-38697
GIBBONS, MICHAEL D.
Calculation of steady and unsteady pressures on wings at supersonic speeds with a transonic small-disturbance code p 617 A91-38544
GIBSON, J. C.
The development of alternate criteria for FBW handling qualities p 666 N91-23113
GIEN, P. H.
Flexural waves induced by electro-impulse deicing forces p 676 A91-38776
GINBURG, DAVID M.
Metal matrix composite vertical tail fabrication
[SME PAPER EM90-438] p 611 A91-36875
GINOVART, C.
Supersonic-hypersonic inlet studies for aerospaceplane p 659 N91-23160
GIURGIUTIU, V.
New developments in the dynamic aeroelastic stability study of rotor blades p 673 A91-36698
GIUSTINIANI, PIERCARLO
Evaluation of the performance of a RISC based real time data processor in air traffic control radar applications p 642 A91-37145
GLOSS, B. B.
National Transonic Facility status p 669 N91-24133
GOAS, JACQUES
Aeronautical meteorology - Safety and economics of commercial air transports p 685 A91-38323
GOEING, MICHAEL
The 2-D supersonic nozzle design p 660 N91-23176
GOLDBERG, MATTHEW S.
The costs and benefits of aircraft availability
[AD-A232660] p 613 N91-23076
GONG, QINGXIANG
Similarities and differences between environment tests and reliability tests in view of vibration p 665 A91-40166
GORADIA, S. H.
Results of correlations for transition location on a clean-up glove installed on an F-14 aircraft and design studies for a laminar glove for the X-29 aircraft accounting for spanwise pressure gradient p 654 N91-24138
GORDNIER, RAYMOND E.
Three-dimensional composite velocity solutions for subsonic/transonic flow p 616 A91-37841
Unsteady Navier-Stokes solutions for a low aspect ratio delta wing
[AD-A233201] p 631 N91-24112
GOROKHOV, S. A.
Entropy effects of hypersonic flow past blunt delta wings p 615 A91-37181
GOTTLIEB, DAVID
Secondary frequencies in the wake of a circular cylinder with vortex shedding p 620 A91-39736
GOULAIN, M.
Noise inside aircraft fuselages subjected to airborne excitations
[REPT-911-111-104] p 689 N91-23853
GRADY, WALTER A.
Do civil flying qualities requirements address military missions for off-the-shelf procurement p 650 N91-23115
GRAY, DAVID L.
A field-deployable digital acoustic measurement system p 689 N91-24078
GREENE, DAVID L.
Commercial aircraft fuel efficiency potential through 2010 p 645 A91-38127
GREENWOOD, STUART W.
Radiation transmission in adverse weather p 675 A91-37880
GREGORY, BILL
US industry enters the green maze p 685 A91-37049
GREK, G. R.
Receptivity and stability of the boundary layer at a high turbulence level p 678 A91-39945
GRIFFIN, O. M.
Vortex shedding and lock-on in bluff body wakes p 675 A91-38689
GRIMSTAD, GREGORY E.
Aircraft Command in Emergency Situations (ACES). Phase 1: Concept development
[DOT/FAA/CT-90/21] p 636 N91-23097
GRUDZINSKI, SIGMUND S.
Development of B-1 antenna measurement test bed p 668 A91-37881
GU, ZHONGGUAN
Further research on mechanical model for 'ground resonance' of helicopters p 665 A91-40164
GUNDY-BURLET, K. L.
Temporally and spatially resolved flow in a two-stage axial compressor. II - Computational assessment
[ASME PAPER 90-GT-299] p 620 A91-39048
GUSEV, IURII I.
Design and development of aviation gas turbine engines p 657 A91-39201
GUSTAVSSON, A. I.
Long time measurements of landing gear loads on SAAB SF-340 commuter aircraft
[FFA-TN-1990-53] p 653 N91-23138
GUTMARK, E.
Subsonic and supersonic combustion using noncircular injectors p 674 A91-37414
GUY, R. WAYNE
Hypersonic propulsion: Status and challenge p 658 N91-23153

H

HAAKE, F. K.
Fatigue crack growth in monolithic titanium aluminides p 670 A91-38809
HAFF, K. W.
Radioluminescent (RL) lighting system development program
[DE91-009743] p 679 N91-23381
HAGISAWA, TOSHIHIKO
All solid-state ASR with adaptive pulse Doppler processing p 641 A91-37107
HAHN, CHARLES D.
Analytical study of the effects of weight on Light Helicopter (LH) exposure to ground-based weapons
[AD-A232024] p 653 N91-23141
HALL, KEN G.
Analytical study of the effects of weight on Light Helicopter (LH) exposure to ground-based weapons
[AD-A232024] p 653 N91-23141
HALL, L. E.
Application of multidisciplinary optimization methods to the design of a supersonic transport
[NASA-TM-104073] p 652 N91-23135
HALL, M. S.
Vortex shedding and lock-on in bluff body wakes p 675 A91-38689
HALL, P.
On the Goertler vortex instability mechanism at hypersonic speeds p 623 A91-39940
HALL, PHILIP
On the instability of hypersonic flow past a wedge p 621 A91-39922
HALLIWELL, I.
A new facility to study three dimensional viscous flow and rotor-stator interaction in turbines p 682 N91-24336
HALLOCK, J. N.
Aircraft wake vortices: An assessment of the current situation
[AD-A231658] p 626 N91-23079
Aircraft wake vortices: An annotated bibliography (1923-1990)
[AD-A233161] p 631 N91-24111
HANCOCK, G. J.
High subsonic flow about a moving spoiler identifying a novel problem of wind tunnel interference p 619 A91-38710
HANSMAN, JOHN
Microburst avoidance simulation tests p 639 N91-24172
HANSON, A. W.
Lightning protection requirements for aircraft: A proposed specification
[RAE-TM-FS(F)-632-ISSUE-1-R] p 641 N91-24186
HANSON, D. B.
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 3: Application of theory for blade loading, wakes, noise, and wing shielding
[NASA-CR-185193] p 688 N91-23850
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 5: Propagation of propeller tone noise through a fuselage boundary layer
[NASA-CR-185195] p 689 N91-23852
HARBOUR, L.
Small Engine Component Technology (SECT) studies
[NASA-CR-175080] p 663 N91-24206
HARDY, GORDON H.
Simulation evaluation of a speed-guidance law for Harrier approach transitions
[NASA-TM-102853] p 668 N91-24209
HARLOFF, G. J.
Viscous three-dimensional analyses for nozzles for hypersonic propulsion p 629 N91-23175
HARRADINE, P. J.
Safety of aging aircraft - Boeing programs for the 1990's
[AIAA PAPER 91-0909] p 612 A91-40563
HARRAH, STEVEN D.
Clutter modeling of the Denver Airport and surrounding areas p 638 N91-24152
HARRAL, M. W.
Advanced airborne oxygen sensors p 655 A91-39387
HARRIS, CHARLES D.
The NASA Langley laminar-flow-control experiment on a swept, supercritical airfoil: Suction coefficient analysis
[NASA-TM-4267] p 629 N91-24098
Laminar-flow wind tunnel experiments p 634 N91-24136
HARTMANN, DIRK F.
Identification strategies for crack shape determination in rotors p 679 A91-40234
HARVEY, WILLIAM D.
The NASA Langley laminar-flow-control experiment on a swept, supercritical airfoil: Suction coefficient analysis
[NASA-TM-4267] p 629 N91-24098
Laminar-flow wind tunnel experiments p 634 N91-24136
Results of correlations for transition location on a clean-up glove installed on an F-14 aircraft and design studies for a laminar glove for the X-29 aircraft accounting for spanwise pressure gradient p 654 N91-24138
HASCHKA, FRIEDRICH
Prismatic sealed Ni-Cd battery for aircraft power p 657 A91-38178
HASLIM, LEONARD A.
Airborne rescue system
[NASA-CASE-ARC-11909-1] p 635 N91-23095
HEAVNER, RICHARD L.
Theoretical evaluation of engine auxiliary inlet design for supersonic V/STOL aircraft
[NASA-CR-187098] p 633 N91-24123
HELLER, H.
AGARD flight test techniques series. Volume 9: Aircraft exterior noise measurement and analysis techniques
[AGARD-AG-300-VOL-9] p 689 N91-24843
HELMERSSON, L.
Long time measurements of landing gear loads on SAAB SF-340 commuter aircraft
[FFA-TN-1990-53] p 653 N91-23138
HENDRICKS, R. C.
Simulation of brush insert for leading-edge-passage convective heat transfer
[NASA-TM-103801] p 679 N91-23409

HERBER, ANDREAS
Airborne Collision Avoidance System (ACAS) in controlled air traffic. Aspects of reciprocal influence in Secondary Surveillance Radar (SSR) radio loads
[ETN-91-99253] p 644 N91-23105
HERBST, W. B.
X-31A at first flight p 651 N91-23131
HESS, RONALD A.
Methodology for the analytical assessment of aircraft handling qualities p 664 A91-37597
Identification of pilot-vehicle dynamics from simulation and flight test p 664 A91-37598
HEYMAN, JOSEPH S.
Quantitative nondestructive evaluation: Requirements for tomorrow's reliability p 681 N91-24074
HEYSE, JOERG
The 2-D supersonic nozzle design
p 660 N91-23176
HINTON, DAVE
Integrated data analysis of July 7, 1990 microburst
p 685 N91-24170
TDWR information on the flight deck
p 640 N91-24176
HIRSA, AMIR HOSSEIN
An experimental investigation of vortex pair interaction with a clean or contaminated free surface
p 680 N91-23419
HIRSCHEL, E. H.
Analysis of numerical solutions for three-dimensional lifting wing flows p 625 A91-40498
HIRSINGER, FRANCIS
A study of supersonic and hypersonic ramjet engines in France from 1950 to 1974 (application on combined cycle aircraft engines) p 658 N91-23149
HO, JAMES
Program plans for aviation safety research
[NIAR-90-32] p 638 N91-24157
Bonded/fusion repair of aircraft structures
p 613 N91-24160
HODGES, DEWEY H.
Stability of hingeless rotors in hover using three-dimensional unsteady aerodynamics
p 663 A91-36358
HOFFMAN, DANIEL J.
Environmental exposure effects on composite materials for commercial aircraft
[NASA-CR-187478] p 672 N91-24358
HOFFMAN, M. J.
Navigation, guidance, and trajectory optimization for hypersonic vehicles p 644 N91-23150
HOH, ROGER H.
Determination of decision-height windows for decelerating IMC approaches in helicopters
p 667 N91-23124
HOLDEMAN, J. D.
A CFD study of jet mixing in reduced flow areas for lower combustor emissions
[NASA-TM-104411] p 661 N91-23185
HOLDEMAN, JAMES D.
Mixing of multiple jets with a confined subsonic crossflow. Summary of NASA-supported experiments and modeling
[NASA-TM-104412] p 662 N91-24202
HOLLAND, K. P.
Fatigue crack growth in monolithic titanium aluminides
p 670 A91-38809
HOLMES, B. J.
Aerodynamic characteristics of crescent and elliptic wings at high angles of attack p 624 A91-40219
HOLMES, BRUCE J.
Aeronautical research in the United States - Challenges for the 1990's p 612 A91-38580
Passive laminar flow control of crossflow vorticity
[NASA-CASE-LAR-13563-1] p 679 N91-23410
HOLMES, R.
The control of rotor vibration using squeeze-film dampers p 677 A91-39590
HOLST, HARMUT
Procedure for determination of three-dimensional wind tunnel wall interferences and wall adaptation in compressible subsonic flow using measured wall pressures
[DLR-FB-90-46] p 628 N91-23088
HOMENTCOVSCHI, D.
Steady linearised aerodynamics. III - Transonic
p 620 A91-39223
HOOPER, E. H.
Beechcraft starship strength certification
p 684 N91-24643
HOOS, JON A.
Experiments on swept-wing boundary layers
p 622 A91-39932
HORI, NORIYUKI
Decoupled flight control via a model-following technique using the Euler operator p 664 A91-37595
HOUSH, CLINTON S.
Aerodynamic characteristics of scissor-wing geometries p 624 A91-40216
HSU, ANDREW T.
Computational analysis of underexpanded jets in the hypersonic regime p 615 A91-37421
HU, B. K.
The performance of 60 deg delta wings: The effects of leading edge radius on vortex flaps and the wing
[CRANFIELD-AERO-9004] p 628 N91-23092
The performance of 60 deg delta wings: The effects of leading edge radius and vortex flaps
[CRANFIELD-AERO-9002] p 653 N91-23140
HU, ZHONGHAN
The design and simulation of an intelligent flight control system p 665 A91-40133
HUANG, WENCHAO
Application of acoustically treated honeycomb sandwich panels in noise control of aircraft cabin
p 648 A91-40160
HUANG, ZEMIN
Air surveying and data analysis for dynamic response of missiles at swept-back wing tip p 647 A91-40156
HUFF, DENNIS L.
Euler flow predictions for an oscillating cascade using a high resolution wave-split scheme
[NASA-TM-104377] p 630 N91-24107
HUFFAKER, R. MILTON
Coherent lidar airborne windshear sensor - Performance evaluation p 655 A91-39873
HUMMEL, D.
Effects of canard position on the aerodynamic characteristics of a close-coupled canard configuration at low speed p 649 A91-40495
HUMPHREYS, W. W.
The effect of streamwise vortices on a turbulent boundary layer exposed to an unsteady adverse pressure gradient p 675 A91-38693
HUSSAINI, M. Y.
Second mode interactions in supersonic boundary layers p 623 A91-39957
HUTCHINS, PETER
Fire detection system for aircraft cargo bays
p 655 A91-36755
HUTCHINSON, JOHN J.
Program plans for aviation safety research
[NIAR-90-32] p 638 N91-24157
HUYNH, H. T.
Handling qualities guidelines for the design of fly-by-wire flight control systems for transport aircraft
p 667 N91-23119
HWANG, C. J.
Numerical investigation of airfoil/jet/fuselage-undersurface flowfields in ground effect p 617 A91-38541
HYNEK, DANIEL
Clutter rejection in Doppler weather radars used for airport wind shear detection p 685 A91-37104

I

IMAI, HIROYUKI
Improvement of atmospheric flight performance of a space vehicle through sensitivity minimization
p 664 A91-37779
INNOCENTI, MARIO
Lateral-direction tracking requirements from simulation data p 686 A91-39436
Metrics for roll response flying qualities
p 650 N91-23118
INOUE, S.
Research on aerodynamic control of blade tip clearance flow in air-cooled turbine
[DE91-764223] p 660 N91-23182
ISHIBASHI, TORAO
SSR signal discrimination from garbled replies
p 642 A91-37121
ISHIDA, TOSHIAKI
NKK premium quality titanium master alloy
p 672 A91-40425
ITOH, NOBUTAKE
Cross-flow instability of 3-D boundary layers on a flat plate p 622 A91-39931
IWAMA, HISAO
Track initiation using MHT in dense environments
p 674 A91-37141

J

JACOBI, L. Y.
IAI hypersonic wind tunnel
[IAITIC-87-1006] p 668 N91-23194
JACOBS, J. H.
A new technique and application for nonlinear acoustic fatigue of stiffened composite panels
p 687 A91-38863
JADIC, I.
On the improvement of the supersonic lifting line theory p 614 A91-36695
Wing calculation in supersonic flow by means of the supersonic lifting line theory p 614 A91-36700
Aerodynamic calculation of tandem wings in supersonic flow by means of SLLT p 614 A91-36724
JAHSMAN, DIRCK
Helicopter in-flight stores jettison p 671 A91-39389
JALLADE, S.
Theoretical study of Goertler vortices - Linear stability approach p 623 A91-39950
JANSSON, D. G.
Designing with composites - A study of design process p 646 A91-38752
JARRAH, M. A. M.
Unsteady aerodynamic loading of delta wings for low and high angles of attack p 617 A91-38680
Visualization of the flow about a delta wing maneuvering in pitch to very high angle of attack p 618 A91-38684
JEGLEY, DAWN C.
Study of thermal-expansion-molded, graphite-epoxy hat-stiffened sandwich panels p 675 A91-37845
JENKINS, JERRY E.
Simplification of nonlinear indicial response models - Assessment for the two-dimensional airfoil case
p 664 A91-37771
JIA, TIESHENG
Design and implementation of real-time computer coordinated force actuating system with multi-input/output
[AD-A233114] p 687 N91-24768
JIA, WEI
A comparison between computation and experiment for flows around airfoil with slat and flap
p 616 A91-37780
JIANG, CHANGSHENG
The design and simulation of an intelligent flight control system p 665 A91-40133
JOHNS, ALBERT L.
Hot gas ingestion test results of a two-poster vectored thrust concept with flow visualization in the NASA Lewis 9- by 15-foot low speed wind tunnel
[AIAA PAPER 90-2268] p 626 A91-40561
JOHNSON, P. D.
An update on SKAD (survival kit air droppable) systems p 635 A91-39384
JOHNSON, WALTER H.
Modification meets Chapter 3 standards
p 612 A91-40181
JONES, J. D.
Full-scale demonstration tests of cabin noise reduction using active vibration control p 646 A91-38549
JONES, JESSE D.
MLS mathematical model validation study using airborne MLS data from Atlantic City International Airport Boeing 727 elevation shadowing flight tests
[DOT-FAA/CT-TN90/55] p 644 N91-24190
JONES, W. R.
Description, characteristics and testing of the NASA airborne radar p 638 N91-24156
JOSYULA, ESWAR
Numerical study of hypersonic dissociated air past blunt bodies p 616 A91-37835
JOULAIN, P.
Kinetic study of a homogeneous propellant primary flame, with and without additive p 671 A91-39690
JUILLEN, J. C.
Experimental and theoretical analysis of natural transition on 'infinite' swept wing p 621 A91-39927
Boundary layer tripping in supersonic flow
p 623 A91-39960

K

KACHANOV, IU. S.
The experimental investigation of stability and receptivity of a swept-wing flow p 623 A91-39944
KADOTA, KOSYU
Modeling for unsteady aerodynamics of rectangular wing in incompressible flow using step responses
p 625 A91-40473
KAEHLER, H.
Small Engine Component Technology (SECT) study. Program report
[NASA-CR-175077] p 662 N91-24204
KAMINER, ISAAC
Integration of four-dimensional guidance with total energy control system p 665 A91-39410

KANAI, KIMIO
Decoupled flight control via a model-following technique using the Euler operator p 664 A91-37595
KANDA, TEKASHI
Mach 4 testing of scramjet inlet models p 615 A91-37418
KANDIL, O. A.
Numerical simulation of steady and unsteady asymmetric vortical flow p 618 A91-38683
KANG, BONGSOON
Relative effectiveness of 2-D vs. 1-D high resolution microwave imageing p 641 A91-37094
KANNO, SHOKICHI
Re-entry flight control of space plane using approximate perfect servo p 664 A91-37778
KAO, T. J.
Developing and utilizing an Euler computational method for predicting the airframe/propulsion effects for an aft-mounted turboprop transport. Volume 2: User guide [NASA-CR-181924-VOL-2] p 632 N91-24119
A general multiblock Euler code for propulsion integration. Volume 1: Theory document [NASA-CR-187484-VOL-1] p 632 N91-24120
A general multiblock Euler code for propulsion integration. Volume 3: User guide for the Euler code [NASA-CR-187484-VOL-3] p 632 N91-24122
KARPOUZIAN, GABRIEL
Asymptotic theory of bending-torsion flutter of high aspect ratio wing in the torsion controlled domain p 675 A91-37846
KARPOV, ALEKSEI V.
Design and development of aviation gas turbine engines p 657 A91-39201
KATZ, AMNON
One-on-one helicopter combat simulated by chess-type lookahead p 668 A91-37775
KATZ, J.
Unsteady aerodynamic loading of delta wings for low and high angles of attack p 617 A91-38680
KATZ, JOSEPH
Static measurements of slender delta wing rolling moment hysteresis p 625 A91-40223
KAUFMAN, A. E.
Optimization of rotor performance in hover using a free wake analysis p 646 A91-38548
KAVAYA, MICHAEL J.
Coherent lidar airborne windshear sensor - Performance evaluation p 655 A91-39873
KAWAZOE, HIROMICHI
Track initiation using MHT in dense environments p 674 A91-37141
KEATING, JAMES F.
SATURN: The next generation radio for NATO p 682 N91-24475
KELLY, JEFFREY J.
Signal processing of aircraft flyover noise [NASA-CR-187546] p 690 N91-24845
KERELIUK, S.
An investigation into the use of side-arm control for civil rotorcraft applications p 667 N91-23123
Determination of decision-height windows for decelerating IMC approaches in helicopters p 667 N91-23124
KHAN, F. A.
Tip vortex/airfoil interaction for a low Reynolds number canard/wing configuration p 617 A91-38545
KIM, K. S.
Application of path-independent integrals to elevated temperature crack growth p 671 A91-38819
KIRTLEY, KEVIN
Average-passage flow model development p 682 N91-24338
KIUCHI, EIICHI
All solid-state ASR with adaptive pulse Doppler processing p 641 A91-37107
KLATTE, R. J.
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 3: Application of theory for blade loading, wakes, noise, and wing shielding [NASA-CR-185193] p 688 N91-23850
KLINGMANN, B.
On the development of turbulent spots in plane Poiseuille flow p 678 A91-39904
KNOX, CHARLES E.
Flight tests show potential benefits of data link as primary communication medium p 643 A91-38577
KNOX, FRANCIS S.
A test of the American Safety Flight Systems, Inc. prebreather/portable oxygen system [AD-A232723] p 636 N91-23100
KOBAYAKAWA, MAKOTO
Improvement of atmospheric flight performance of a space vehicle through sensitivity minimization p 664 A91-37779
KOBLISH, T. R.
Airblast atomization at conditions of low air velocity p 674 A91-37410
KOCH-PETERS, DOROTHEA
Flight mechanics/air navigation research field. A 1990 Scientific report of the German Air and Space Research Organization [ISSN-0720-7808] p 643 N91-23103
KOCH, RALPH
Canopy breaking system for non-delay pilot rescue p 647 A91-39398
KOEHLER, R.
Development of MIL-8785C into a handling qualities specification for a new European fighter aircraft p 666 N91-23114
KOHAMA, Y.
Development and interaction of instabilities in the crossflow field p 622 A91-39938
KOMURO, TOMOYUKI
Mach 4 testing of scramjet inlet models p 615 A91-37418
KOODALATTUPURAM, CHITHRABHANU
An experimental study of an axisymmetric turbulent boundary layer disturbed by a periodic freestream p 626 N91-23078
KOOPMAN, J.
Aerodynamics and stabilization of combustion of hydrogen jets injected into subsonic airflow p 629 N91-23164
KOPPER, F. C.
Coolant side heat transfer with rotation. Task 3 report: Application of computational fluid dynamics [NASA-CR-182109] p 683 N91-24551
KORS, DAVID L.
Design considerations for combined air breathing-rocket propulsion systems [AIAA-90-0098] p 659 N91-23158
KORTING, P. A. O. G.
Theoretical and experimental performance of a solid fuel ramjet combustion cycle for hypersonic flight conditions p 660 N91-23170
KOSUGE, YOSHIO
Track initiation using MHT in dense environments p 674 A91-37141
KOUROUPIS, J. B.
A simplified aerothermal heating method for axisymmetric blunt bodies p 619 A91-38787
KOVALEVSKAIA, A. E.
Design and development of aviation gas turbine engines p 657 A91-39201
KOZLOV, V. V.
Receptivity and stability of the boundary layer at a high turbulence level p 678 A91-39945
KRAVCHENKO, A. G.
Characteristics of the reception by the antenna systems of a descending aircraft of signals from radio-beacon landing systems p 642 A91-37200
KREISS, W. T.
Model for IR sensor performance evaluation - Applications and results p 656 A91-39890
KREMER, FRANS G. J.
Trajectory optimization considerations for ramjet engines p 658 N91-23151
KROO, ILAN
Nonlinear Aerodynamics and the Design of Wing Tips [NASA-CR-188044] p 630 N91-24105
The computation of induced drag with nonplanar and deformed wakes p 630 N91-24106
KROTHAPALLI, A.
Unsteady flow past an airfoil pitched at constant rate p 617 A91-38679
KUDO, KENJI
Mach 4 testing of scramjet inlet models p 615 A91-37418
KUENKLER, H.
Airbreathing propulsion for space transport: New concepts, special problems and attempts at solutions p 658 N91-23154
KUHN, PETER M.
An airborne FLIR detection and warning system for low altitude wind shear p 637 N91-24147
KUHN, RICHARD E.
Suckdown, fountain lift, and pressures induced on several tandem jet V/STOL configurations [NASA-TM-102817] p 630 N91-24108
KUNTZ, H. L.
Laboratory test and acoustic analysis of cabin treatment for propfan test assessment aircraft [NASA-CR-182075] p 690 N91-24844
KUSUNOSE, K.
Developing and utilizing an Euler computational method for predicting the airframe/propulsion effects for an aft-mounted turboprop transport. Volume 2: User guide [NASA-CR-181924-VOL-2] p 632 N91-24119
KWON, O. J.
Simulation of iced wing aerodynamics [NASA-TM-104362] p 628 N91-23086
KWON, OH J.
Stability of hingeless rotors in hover using three-dimensional unsteady aerodynamics p 663 A91-36358

L

LADDEN, R. M.
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 3: Application of theory for blade loading, wakes, noise, and wing shielding [NASA-CR-185193] p 688 N91-23850
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 4: Computer user's manual for UAAP turboprop aeroacoustic code [NASA-CR-185194] p 688 N91-23851
LAGRAFF, JOHN E.
An isentropic compression-heated Ludweig tube transient wind tunnel p 673 A91-36450
LAI, H. T.
Viscous three-dimensional analyses for nozzles for hypersonic propulsion p 629 N91-23175
LAKSHMINARAYANA, B.
A new facility to study three dimensional viscous flow and rotor-stator interaction in turbines p 682 N91-24336
LAMBERTDEROUVROIT, M.
Aero-thermal investigation of a highly loaded transonic linear turbine guide vane cascade. A test case for inviscid and viscous flow computations [VKI-TN-174] p 680 N91-23437
LAN, C. E.
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 1: Steady [AD-A233482] p 631 N91-24113
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 2: User manual for VORSTAB-2 [AD-A233483] p 631 N91-24114
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 3: Unsteady [AD-A233569] p 631 N91-24115
LANDRY, MURPHY J.
Demonstration of a Laser Ordnance Initiation System in an F-16 sled p 646 A91-39377
LANG, JUERGEN
Air travel - System relating flight safety, aircraft, and airports p 634 A91-38527
LANICH, W.
Model for IR sensor performance evaluation - Applications and results p 656 A91-39890
LANKARANI, HAMID M.
Feasibility study in crack detection in aircraft stiffened panels by pulse probing and deconvolution p 654 N91-24158
Mechanical paint removal techniques for composite aircraft p 613 N91-24163
LARKIN, T. R.
Small Engine Component Technology (SECT) study [NASA-CR-175081] p 663 N91-24207
LARSEN, JAMES M.
Titanium aluminides for aerospace applications p 671 A91-39302
LAYTON, DONALD
Aircraft performance p 649 A91-40511
LEE, CALVIN K.
Low Altitude High Speed Cargo Parachute system development - A status report [AIAA PAPER 91-0880] p 635 A91-40558
LEE, IN
Supersonic flutter analysis of clamped symmetric composite panels using shear deformable finite elements p 675 A91-37847
LEFEBVRE, A. H.
Airblast atomization at conditions of low air velocity p 674 A91-37410
LEGGETT, DAVID B.
MIL-STD-1797 is not a cookbook p 650 N91-23111
LEROUX, C.
RADAR performance experiments p 639 N91-24168
LEVCHENKO, V. IA.
Boundary layer control by a local heating of the wall p 678 A91-39909
LEVIN, DANIEL
Static measurements of slender delta wing rolling moment hysteresis p 625 A91-40223
LEVY, RALPH
A design strategy for the use of vortex generators to manage inlet-engine distortion using computational fluid dynamics [NASA-TM-104436] p 633 N91-24131

LEWIS, MIKE
NASA Langley flight test program p 639 N91-24175
LI, BINGGONG
Integration of vibration test and flutter analysis - A brief introduction to 'a real-time flutter analysis system' p 665 A91-40168
LI, ZHONG
Further research on mechanical model for 'ground resonance' of helicopters p 665 A91-40164
LIANG, JUNXIANG
On digital electronic control system of aircraft engine p 657 A91-38209
LIBRESCU, LIVIU
Analytical studies on static aeroelastic behavior of forward-swept composite wing structures p 674 A91-37774
LIDEN, SAM
Practical considerations in optimal and 4-dimensional flight management computations p 686 A91-37585
LIEBECK, R. H.
Calculation of low Reynolds number flows at high angles of attack p 624 A91-40218
LIN, M. H.
Computation of axisymmetric slender bodies enclosing a jet efflux in pitching oscillatory motion p 618 A91-38681
LIOU, MENG-SING
Computational analysis of underexpanded jets in the hypersonic regime p 615 A91-37421
LIU, C. H.
Numerical simulation of steady and unsteady asymmetric vortical flow p 618 A91-38683
LIU, GAOLIAN
A new pseudo-potential function model for rotational flow and its application to transonic-supersonic flow p 625 A91-40373
LIU, J. L.
Numerical investigation of airfoil/jet/fuselage-undersurface flowfields in ground effect p 617 A91-38541
LIU, JIN
Flexure vibration test method of aviation tube p 648 A91-40172
LIU, JINGHOU
Experimental investigation on supersonic combustion p 657 A91-38203
LIU, X.
Actual stresses in notches - How applicable are the common stress concentration factors? p 676 A91-38775
LIU, XINGZHOU
Experimental investigation on supersonic combustion p 657 A91-38203
LIU, YONG
Computation of three-dimensional flow fields through compressor blade rows p 625 A91-40375
LIVNE, ELIEZER
Integrated multidisciplinary optimization of actively controlled fiber composite wings p 667 N91-23190
LOC, TA P.
Further experiments on vortex formation around an oscillating and translating airfoil at large incidences p 620 A91-39738
LOCATELLI, J.
Validation of in-house and external software systems at Aerospatiale p 687 N91-24640
LOOMIS, MARK PAUL
Interferometric investigation of supersonic flow fields with shock-shock interactions p 627 N91-23082
LOURENCO, L.
Unsteady flow past an airfoil pitched at constant rate p 617 A91-38679
LOVENGUTH, MARC
Technology needs for high-speed rotorcraft [NASA-CR-177578] p 652 N91-23136
LU, FRANK K.
Inception length to a fully developed, fin-generated, shock-wave, boundary-layer interaction p 617 A91-37842
LUCKRING, JAMES M.
Reynolds number effects on the transonic aerodynamics of a slender wing-body configuration p 634 N91-24134
LUO, SHIJUN
Synchronous iterative method for computation of vortex flows at high angles of attack p 624 A91-40126
LUONG, T. M.
Full-scale demonstration tests of cabin noise reduction using active vibration control p 646 A91-38549
LUPO, M.
Variable-property effects in supersonic wedge flow p 616 A91-37832
LYRINTZIS, A. S.
Acoustics of unsteady transonic flow p 687 A91-38688
LYRINTZIS, ANASTASIOS S.
A study of the noise mechanisms of transonic blade-vortex interactions [NASA-CR-188199] p 627 N91-23084

M

MA, GUOZHONG
The planar elements method for computing the scattering field of flight vehicle p 674 A91-37052
MABEY, DENNIS G.
Calculation of steady and unsteady pressures on wings at supersonic speeds with a transonic small-disturbance code p 617 A91-38544
MACHA, J. M.
An introduction to testing parachutes in wind tunnels [AIAA PAPER 91-0858] p 668 A91-40556
MACRET, JEAN-LUC
Oxidation resistant carbon/carbon materials [REPT-911-430-105] p 672 N91-23251
MADDALON, DAL V.
Laminar-flow flight experiments p 634 N91-24135
Evaluation of cloud detection instruments and performance of laminar-flow leading-edge test articles during NASA Leading-Edge Flight-Test Program [NASA-TP-2888] p 655 N91-24199
MAGARI, PATRICK J.
An isentropic compression-heated Ludweig tube transient wind tunnel p 673 A91-36450
MAGLIOZZI, B.
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 5: Propagation of propeller tone noise through a fuselage boundary layer [NASA-CR-185195] p 689 N91-23852
MAIURANO, M.
Airbreathing propulsion for transatmospheric flight p 659 N91-23156
MAJOROS, ANTHONY E.
Aircraft design for maintainability p 612 A91-38546
MAKHAN'KOV, V. V.
Discontinuous solutions for a three-dimensional hypersonic boundary layer with interaction p 614 A91-37176
MALIK, M. R.
Real gas effects on hypersonic boundary-layer stability p 614 A91-36453
Transition research in low-disturbance high-speed wind tunnels p 621 A91-39919
MALLWITZ, ROLAND
Airborne Collision Avoidance System (ACAS) in controlled air traffic. Aspects of reciprocal influence in Secondary Surveillance Radar (SSR) radio loads [ETN-91-99253] p 644 N91-23105
MALONE, J. B.
Airfoil design method using the Navier-Stokes equations p 646 A91-38550
MANGOLD, PETER
Integration of handling quality aspects into the aerodynamic design of modern unstable fighters p 667 N91-23125
MANKBADI, R. R.
Heat transfer in oscillating flows p 676 A91-38698
MAO, ZHISHANG
Numerical analysis of solid-fuel interactive vibration on an aircraft integral tank p 648 A91-40161
MARCHAND, M.
Development of MIL-8785C into a handling qualities specification for a new European fighter aircraft p 666 N91-23114
MARESCA, C.
A new system for unsteady aerodynamics of moving wall p 618 A91-38695
MARGUET, ROGER
A study of supersonic and hypersonic ramjet engines in France from 1950 to 1974 (application on combined cycle aircraft engines) p 658 N91-23149
MARTIN, CHRISTOPHER
Technology needs for high-speed rotorcraft [NASA-CR-177578] p 652 N91-23136
MARTIN, PHILIPPE
The certification of the aircraft integrated propulsive system [REPT-911-111-102] p 661 N91-23188
MASUDA, S.
Visual study of boundary layer transition on rotating flat plate p 623 A91-39941
MASUYA, GORO
Mach 4 testing of scramjet inlet models p 615 A91-37418
MATHEWS, BRUCE D.
Saberliner flight test for airborne wind shear forward looking detection and avoidance radar systems p 637 N91-24149
MATSUBARA, M.
Visual study of boundary layer transition on rotating flat plate p 623 A91-39941
MATSUSHITA, H.
ACT wind-tunnel experiments of a transport-type wing p 615 A91-37772
MATTHEWS, WILLIAM T.
Model sensitivity in stress-strength reliability computations [AD-A232023] p 681 N91-23554
MAVRIPLIS, DIMITRI J.
Implicit solvers for unstructured meshes [NASA-CR-187564] p 633 N91-24125
MAZZA, C. J.
Agility: A rational development of fundamental metrics and their relationship to flying qualities p 651 N91-23129
MCCLURE, M. D.
Computation of inlet reference plane flow-field for a subscale free-jet forebody/inlet model and comparison to experimental data [AD-A232101] p 680 N91-23445
MCCOLGAN, C. J.
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 3: Application of theory for blade loading, wakes, noise, and wing shielding [NASA-CR-185193] p 688 N91-23850
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 4: Computer user's manual for UAAP turboprop aeroacoustic code [NASA-CR-185194] p 688 N91-23851
MCCONNELL, PATRICK
The role of analysis in the design and qualification of composite aircraft structures p 684 N91-24648
MCCORMICK, DUANE C.
Experimental investigation of loading effects on compressor trailing-edge flowfields p 615 A91-37420
MCDONALD, DANN C.
Do civil flying qualities requirements address military missions for off-the-shelf procurement p 650 N91-23115
MCILVAINE, M.
Calculation of low Reynolds number flows at high angles of attack p 624 A91-40218
MCKAY, K.
A review of high angle of attack requirements for combat aircraft p 651 N91-23130
MCKINNEY, L. W.
National Transonic Facility status p 669 N91-24133
MCKISSICK, BURNELL
Status of NASA's IR wind shear detection research p 637 N91-24145
MCMANUS, KEITH ROBERT
The effects of controlling vortex formation on the performance of a dump combustor p 672 N91-23270
MEHDI, I. S.
Advanced aircraft secondary power system design p 656 A91-38007
MEHROTRA, S. C.
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 1: Steady [AD-A233482] p 631 N91-24113
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 2: User manual for VORSTAB-2 [AD-A233483] p 631 N91-24114
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 3: Unsteady [AD-A233569] p 631 N91-24115
MEISSNER, C. W., JR.
NASA-LaRc Flight-Critical Digital Systems Technology Workshop [NASA-CP-10028] p 655 N91-24200
MELLO, OLYMPIO A. F.
Unsteady, frequency-domain analysis of helicopter non-rotating lifting surfaces p 613 A91-36359
MENEES, GENE P.
Analytical and experimental investigations of the oblique detonation wave engine concept p 660 N91-23169
MENTHE, R. W.
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 4: Computer user's manual for UAAP turboprop aeroacoustic code [NASA-CR-185194] p 688 N91-23851
MERLEN, ALAIN
Stream functions for the hypersonic flow around quasi-pointed slender bodies at low angles of attack p 621 A91-39832
MERRICK, VERNON K.
Simulation evaluation of a speed-guidance law for Harrier approach transitions [NASA-TM-102853] p 668 N91-24209
MERRILL, WALTER C.
Sensor failure detection for jet engines p 656 A91-37593

MESANDER, GEERT A.
Advanced ice protection systems test in the NASA Lewis icing research tunnel
[NASA-TM-103757] p 661 N91-23183
MEYER, P. K.
Small Engine Component Technology (SECT) studies
[NASA-CR-175080] p 663 N91-24206
MEYER, ROBERT R., JR.
Effects of wing sweep on in-flight boundary-layer transition for a laminar flow wing at Mach numbers from 0.60 to 0.79
[NASA-TM-101701] p 683 N91-24555
Effects of wing sweep on boundary-layer transition for a smooth F-14A wing at Mach numbers from 0.700 to 0.825
[NASA-TM-101712] p 683 N91-24556
MEYER, T. G.
Notched fatigue of single crystal PWA 1480 at turbine attachment temperatures p 682 N91-24310
MIALLIER, BERNARD
Current status and future prospects of air traffic control p 642 A91-38322
MICHEL, R.
Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Ecole Nationale Superieure de l'Aeronautique et de l'Espace, Toulouse, France, Sept. 11-15, 1989 p 677 A91-39901
MIKI, KAZUO
Aerodynamic characteristics of slender wing-gap-body combinations p 615 A91-37777
MILLER, BRIAN A.
Fighter escape system - The next step forward p 646 A91-39382
MILLER, M.
Safety of aging aircraft - Boeing programs for the 1990's
[AIAA PAPER 91-0909] p 612 A91-40563
MINH, H. H.
Theoretical study of Goertler vortices - Linear stability approach p 623 A91-39950
MINODA, M.
Research on aerodynamic control of blade tip clearance flow in air-cooled turbine
[DE91-764223] p 660 N91-23182
MIROW, P.
Investigations on flow instabilities on airfoils by means of piezofoil-arrays p 621 A91-39911
MITCHELL, CLARK
Technology needs for high-speed rotorcraft
[NASA-CR-177578] p 652 N91-23136
MITCHELL, JOSEPH
Crashworthiness experiments p 638 N91-24161
MITCHELL, ROBERT A.
A test of the American Safety Flight Systems, Inc. prebreather/portable oxygen system
[AD-A232723] p 636 N91-23100
MIYAZAWA, Y.
ACT wind-tunnel experiments of a transport-type wing p 615 A91-37772
MODI, V. J.
Moving surface boundary-layer control as applied to two-dimensional airfoils p 615 A91-37768
MOKHTARIAN, F.
Moving surface boundary-layer control as applied to two-dimensional airfoils p 615 A91-37768
MOOK, D. T.
Application of vortex dynamics to simulations of two-dimensional wakes p 676 A91-38706
MOORHOUSE, DAVID J.
The handling qualities of the STOL and maneuver technology demonstrator from specification to flight test p 666 N91-23117
MORALEZ, ERNESTO
Simulation evaluation of a speed-guidance law for Harrier approach transitions
[NASA-TM-102853] p 668 N91-24209
MORGAN, H. L.
Results of correlations for transition location on a clean-up glove installed on an F-14 aircraft and design studies for a laminar glove for the X-29 aircraft accounting for spanwise pressure gradient p 654 N91-24138
MORGAN, J. MURRAY
An initial study into the influence of control stick characteristics on the handling qualities of a fly-by-wire helicopter p 651 N91-23122
MORKOVIN, M. V.
Dialogue on progress and issues in stability and transition research p 677 A91-39902
MORSE, CHANNING S.
ADFCS and NOTAR (trademark): Two ways to fix flying qualities p 650 N91-23110
MOST, J. M.
Kinetic study of a homogeneous propellant primary flame, with and without additive p 671 A91-39690
MOUNIR, H.
RADAR performance experiments p 639 N91-24168
MOUSSEUX, MARC C.
Experiments on swept-wing boundary layers p 622 A91-39932
MUELLER, T. J.
Tip vortex/airfoil interaction for a low Reynolds number canard/wing configuration p 617 A91-38545
MUKHOPADHYAY, VIVEKANANDA
Control law synthesis and stability robustness improvement using constrained optimization techniques p 686 A91-37591
MULLEN, R. L.
Simulation of brush insert for leading-edge-passage convective heat transfer
[NASA-TM-103801] p 679 N91-23409
MURAKAMI, ATSUO
Mach 4 testing of scramjet inlet models p 615 A91-37418
MURPHY, S. D.
Automated CAD design for sculptured airfoil surfaces
[SME PAPER MS90-744] p 673 A91-36943
MUZZY, WILLIAM H., III
The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the copilot/gunner, volume 1
[AD-A233349] p 641 N91-24188

N

NAKAGAWA, KEIICHI
NKK premium quality titanium master alloy p 672 A91-40425
NAKAMURA, HIROSHI
All solid-state ASR with adaptive pulse Doppler processing p 641 A91-37107
NAKAMURA, YOSHIAKI
A comparison between computation and experiment for flows around airfoil with slat and flap p 616 A91-37780
NAKAMURA, YUKINOBU
Improvement of atmospheric flight performance of a space vehicle through sensitivity minimization p 664 A91-37779
NARRAMORE, J. C.
Airfoil design method using the Navier-Stokes equations p 646 A91-38550
NAYUKI, TOSHIO
NKK premium quality titanium master alloy p 672 A91-40425
NEAL, DONALD M.
Model sensitivity in stress-strength reliability computations
[AD-A232023] p 681 N91-23554
NEBACK, H. E.
Developing and utilizing an Euler computational method for predicting the airframe/propulsion effects for an aft-mounted turboprop transport. Volume 2: User guide
[NASA-CR-181924-VOL-2] p 632 N91-24119
NEINER, GEORGE
Hot gas ingestion test results of a two-poster vectored thrust concept with flow visualization in the NASA Lewis 9- by 15-foot low speed wind tunnel
[AIAA PAPER 90-2268] p 626 A91-40561
NELSON, HAROLD
National airspace system. Communications operational concept NAS-SR-136
[DOT/FAA/SE-91/1] p 640 N91-24185
NELSON, LOREN
Continuous wave laser for wind shear detection p 637 N91-24142
NELSON, RICHARD S.
Application of cyclic damage accumulation life prediction model to high temperature components p 681 N91-24309
NELSON, ROBERT C.
Breaking down the delta wing vortex: The role of vorticity in the breakdown process
[NASA-CR-188235] p 630 N91-24109
NEWMAN, ROBERT
Air ambulance helicopter operational analysis
[DOT/FAA/RD-91/7] p 652 N91-23134
NI, XUEREN
A numerical method for simulating drop test of landing gears p 648 A91-40174
NICHOLAS, O. P.
Handling qualities guidelines for the design of fly-by-wire flight control systems for transport aircraft p 667 N91-23119
NICHOLAS, T.
Fatigue crack growth modeling at elevated temperature using fracture mechanics p 671 A91-38812
NIEUWPOORT, ANTON M. H.
Evaluation techniques for highly augmented aircraft
[DLR-FB-90-35] p 667 N91-23191
NIKIFORUK, PETER N.
Decoupled flight control via a model-following technique using the Euler operator p 664 A91-37595
NIKITIN, IU. M.
Design and development of aviation gas turbine engines p 657 A91-39201
NIKOLAIDIS, E.
Design of aircraft wings subjected to gust loads - A safety index based approach p 675 A91-37851
NING, WEI
Computation of three-dimensional flow fields through compressor blade rows p 625 A91-40375
NING, XUEZHEN
A study on sonic load of the vertical tail of F-7 aircraft p 648 A91-40171
NISSLEY, D. M.
Notched fatigue of single crystal PWA 1480 at turbine attachment temperatures p 682 N91-24310
NITSCHE, W.
Investigations on flow instabilities on airfoils by means of piezofoil-arrays p 621 A91-39911
NOSE, H.
Research on aerodynamic control of blade tip clearance flow in air-cooled turbine
[DE91-764223] p 660 N91-23182

O

O'MARA, T. M.
Effects of horizontal tail ice on longitudinal aerodynamic derivatives p 665 A91-38547
O'SHAUGHNESSY, PATRICK
Integration of four-dimensional guidance with total energy control system p 665 A91-39410
OCH, F.
Analytical methods for the qualification of helicopter structures p 684 N91-24650
ODAM, G. A. M.
Lightning protection requirements for aircraft: A proposed specification
[RAE-TM-FS(F)-632-ISSUE-1-R] p 641 N91-24186
OEFELEIN, J. C.
Experiments on the unsteadiness associated with a ground vortex p 624 A91-40220
OELKER, H.-CHR.
Effects of canard position on the aerodynamic characteristics of a close-coupled canard configuration at low speed p 649 A91-40495
OHMI, KAZUO
Further experiments on vortex formation around an oscillating and translating airfoil at large incidences p 620 A91-39738
OHMORI, SHINGO
High gain airborne antenna for satellite communications p 643 A91-39776
OHTA, F.
Development and interaction of instabilities in the crossflow field p 622 A91-39938
OHTA, HIROBUMI
Re-entry flight control of space plane using approximate perfect servo p 664 A91-37778
ONCESCU, F.
New developments in the dynamic aeroelastic stability study of rotor blades p 673 A91-36698
ONO, TAKANORI
NKK premium quality titanium master alloy p 672 A91-40425
ONOFRI, M.
Reacting shock waves in hypersonic propulsion applications p 629 N91-23174
ONSTOTT, ROBERT G.
Clutter modeling of the Denver Airport and surrounding areas p 638 N91-24152
OPPELT, J. B.
An experimental evaluation of combustor liner materials for solid fuel ramjet testing p 670 N91-24289
ORMISTON, ROBERT A.
Rotor-fuselage dynamics of helicopter air and ground resonance p 645 A91-36357
OROURKE, MATTHEW
Technology needs for high-speed rotorcraft
[NASA-CR-177578] p 652 N91-23136
OWEN, ALBERT K.
Effects of inlet distortion on the development of secondary flows in a subsonic axial inlet compressor rotor
[NASA-TM-104356] p 660 N91-23179

P

PANDOLFINI, P. P.
Design techniques for dual mode ram-scramjet combustors p 659 N91-23166
PAPADAKIS, MICHAEL
Water droplet impingement on airfoils and aircraft engine inlets for icing analysis p 634 A91-38543
PAPAGEORGIOU, DEMETRIOS T.
The stability to two-dimensional wakes and shear layers at high Mach numbers p 614 A91-36452
PAPAMOSCHOU, DIMITRI
Structure of the compressible turbulent shear layer p 616 A91-37830
PAPAZIAN, H.
Forebody vortex control with the unsteady bleed technique p 617 A91-37859
PARKINSON, A. G.
Balancing of rotating machinery p 679 A91-40278
PARSONS, MICHAEL L.
Fire detection system for aircraft cargo bays p 655 A91-36755
PATEL, VADANKUMAR M.
A test of the American Safety Flight Systems, Inc. prebreather/portable oxygen system [AD-A232723] p 636 N91-23100
PATERSON, ROBERT W.
Experimental investigation of loading effects on compressor trailing-edge flowfields p 615 A91-37420
PAUSDER, HEINZ-JUERGEN
Handling qualities evaluation for highly augmented helicopters p 651 N91-23128
PEERHOSSAINI, H.
A model for the experimental study of curvature effects on transition of the boundary layer on a swept wing - Preliminary results p 620 A91-39691
PEGUES, W. J.
Numerical study of twin-jet impingement upwash flow p 619 A91-38736
PELLETIER, DOMINIQUE H.
Three-dimensional finite element method analysis of turbulent flow over self-propelled slender bodies p 615 A91-37419
PELLOUX, REGIS M.
Modeling of creep-fatigue interaction effects on crack growth p 670 A91-38802
PEPIN, FRANCOIS
Simulation of the flow past an impulsively started cylinder using a discrete vortex method [AD-A233066] p 683 N91-24533
PERES, P.
How to know CMC [REPT-911-430-130] p 672 N91-23262
PERSELLO, L. F.
Differential GPS terminal area test results [AD-A232668] p 644 N91-23106
PETERS, HANNS-JUERGEN
The limits of the landing process of aircraft [DLR-FB-90-49] p 653 N91-23137
PETERSEN, RICHARD H.
Aeronautical research in the United States - Challenges for the 1990's p 612 A91-38580
PETIAU, C.
Influence of the refinement of structural calculation on aircraft qualification procedures p 684 N91-24649
PFENNINGER, W.
Blunt-nosed swept supercritical LFC wings without nose flaps p 622 A91-39936
PHILLIPS, J. M.
Deep stall of an NACA 0012 airfoil induced by periodic aerodynamic interference p 619 A91-38699
PICKERELL, THOMAS
National airspace system. Communications operational concept NAS-SR-136 [DOT/FAA/SE-91/1] p 640 N91-24185
PINDERA, J. T.
Actual stresses in notches - How applicable are the common stress concentration factors? p 676 A91-38775
PITTMAN, JAMES L.
Euler analysis of a High-Speed Civil Transport concept at Mach 3 p 624 A91-40217
POLIAKOV, A. M.
Entropy effects of hypersonic flow past blunt delta wings p 615 A91-37181
POLL, D. I. A.
The effect of isolated roughness elements on transition in attachment-line flows p 678 A91-39959
POTAPCZUK, M. G.
Simulation of iced wing aerodynamics [NASA-TM-104362] p 628 N91-23086
Icing simulation: A survey of computer models and experimental facilities [NASA-TM-104366] p 628 N91-23087
POULOSE, M. M.
Microwave landing system modeling with application to air traffic control [NASA-TM-102832] p 636 N91-23099
POZZI, A.
Variable-property effects in supersonic wedge flow p 616 A91-37832
PREISSLER, HARALD
Equation decoupling - A new approach to the aerodynamic identification of unstable aircraft p 664 A91-37773
PRICE, FLOYD
Kansas Aviation Review [NIAR-91-3] p 613 N91-24087
PRICE, ROBERT O.
Methanol - An environmentally attractive alternative commercial aviation fuel p 670 A91-38129
PRIKLONSKAIA, V. I.
Evaluation of the phase distortions of the input signal of a synthetic-aperture radar p 677 A91-39144
PRUETT, D. J.
Radioluminescent (RL) lighting system development program [DE91-009743] p 679 N91-23381
PUJARA, L. R.
A computer aided multivariable control systems design technique with application to aircraft flying qualities [AD-A232549] p 653 N91-23144
PUMA, SAM
Northrop advanced fighter crew protection system. I - Engineering development. II - System development, test and evaluation p 647 A91-39395
PUYPLAT, DIDIER
A320 - First of the computer-age aircraft p 645 A91-36354

Q

QI, PIQIAN
Integration of vibration test and flutter analysis - A brief introduction to 'a real-time flutter analysis system' p 665 A91-40168
QIU, HUASHOU
CAPP imitative system of aircraft assembly p 611 A91-37061
QU, JIANZHONG
Application of identification method of modal parameters to flight flutter test p 665 A91-40167
QUACKENBUSH, T. R.
Optimization of rotor performance in hover using a free wake analysis p 646 A91-38548

R

RACHNER, M.
Aerodynamics and stabilization of combustion of hydrogen jets injected into subsonic airflow p 629 N91-23164
RADESPIEL, R.
Cell centered and cell vertex multigrid schemes for the Navier-Stokes equations p 674 A91-37834
RAI, M. M.
Temporally and spatially resolved flow in a two-stage axial compressor. II - Computational assessment [ASME PAPER 90-GT-299] p 620 A91-39048
RAMAZANOV, M. P.
Receptivity and stability of the boundary layer at a high turbulence level p 678 A91-39945
RAMETTE, PHILIPPE
Comparative study of different systems of combined cycle propulsion p 658 N91-23152
RAMEY, D. W.
Radioluminescent (RL) lighting system development program [DE91-009743] p 679 N91-23381
RAMM, HEINRICH J.
Fluid dynamics for the study of transonic flow p 625 A91-40513
RANAUDO, R. J.
Effects of horizontal tail ice on longitudinal aerodynamic derivatives p 665 A91-38547
RAND, OMRI
Unsteady, frequency-domain analysis of helicopter non-rotating lifting surfaces p 613 A91-36359
REDDY, D. R.
Viscous three-dimensional analyses for nozzles for hypersonic propulsion p 629 N91-23175
The 3-D Navier-Stokes analysis of crossing, glancing shocks/turbulent boundary layer interactions [NASA-TM-104469] p 633 N91-24130
REDDY, T. S. R.
Euler flow predictions for an oscillating cascade using a high resolution wave-split scheme [NASA-TM-104377] p 630 N91-24107
REDEKER, G.
Forward sweep - A favorable concept for a laminar flow wing p 615 A91-37767
REDIESS, HERMAN A.
National remote computational flight research facility [NASA-CR-179432] p 668 N91-24210
REEHORST, A. L.
Effects of horizontal tail ice on longitudinal aerodynamic derivatives p 665 A91-38547
REINMANN, J. J.
Icing simulation: A survey of computer models and experimental facilities [NASA-TM-104366] p 628 N91-23087
RENZO, BAVA
Flying qualities experience on the AMX aircraft p 650 N91-23112
RESHOTKO, E.
Dialogue on progress and issues in stability and transition research p 677 A91-39902
REYNOLDS, THOMAS L.
Aircraft Command in Emergency Situations (ACES). Phase 1: Concept development [DOT/FAA/CT-90/21] p 636 N91-23097
REYNOLDS, W. C.
The effect of streamwise vortices on a turbulent boundary layer exposed to an unsteady adverse pressure gradient p 675 A91-38693
RIBAUD, YVES
Compact heat exchanger for an inverse components engine p 659 N91-23157
RICCOBONO, ALDO
Adaptive airborne track while scan p 642 A91-37139
RILEY, M. F.
Application of multidisciplinary optimization methods to the design of a supersonic transport [NASA-TM-104073] p 652 N91-23135
ROBERTS, A. S., JR.
Airfoil transition and separation studies using an infrared imaging system p 624 A91-40215
ROBERTS, EDWARD O.
The technical challenges of the crew escape technologies program p 612 A91-39392
ROBERTSON, ROY E.
Wind Shear radar program future plans p 637 N91-24151
ROCKWELL, DONALD
Unsteady flow structure from swept edges subjected to controlled motion [AD-A232714] p 628 N91-23094
ROHATGI, UPENDRA S.
Fluid Machinery Forum - 1990; ASME Spring Meeting, University of Toronto, Canada, June 4-7, 1990, Proceedings p 676 A91-38869
ROKHSAZ, KAMRAN
Aerodynamic characteristics of scissor-wing geometries p 624 A91-40216
ROLLBUHLER, R. JAMES
Fuel-rich, catalytic reaction experimental results [NASA-TM-104423] p 662 N91-24203
RONQUILLO, KENNETH L.
Low Altitude High Speed Cargo Parachute system development - A status report [AIAA PAPER 91-0880] p 635 A91-40558
ROSEN, A.
Ground resonance of a helicopter with inter-connected blades p 645 A91-36360
ROSKAM, JAN
Evolution of airplane stability and control - A designer's viewpoint p 665 A91-39401
ROSS, ARTHUR
One-on-one helicopter combat simulated by chess-type lookahead p 668 A91-37775
ROWLAND, WAYNE D.
A field-deployable digital acoustic measurement system p 689 N91-24078
ROZENDAAL, RODGER A.
Variable Sweep Transition Flight Experiment (VSTFE): Unified Stability System (USS). Description and users' manual [NASA-CR-181918] p 634 N91-24139
RUAN, Y. F.
Modal analysis of multistage gear systems coupled with gearbox vibrations [NASA-TM-103797] p 681 N91-23513
RUBERTUS, C. S.
Advanced aircraft secondary power system design p 656 A91-38007
RUBIN, STANLEY G.
Three-dimensional composite velocity solutions for subsonic/transonic flow p 616 A91-37841
RUDY, DAVID H.
Secondary frequencies in the wake of a circular cylinder with vortex shedding p 620 A91-39736

RUTHERFORD, A. W.
Aero-thermal investigation of a highly loaded transonic linear turbine guide vane cascade. A test case for inviscid and viscous flow computations
[VKI-TN-174] p 680 N91-23437
RUTHERFORD, JOHN
Technology needs for high-speed rotorcraft
[NASA-CR-177578] p 652 N91-23136

S

SADECK, JAMES E.
Low Altitude High Speed Cargo Parachute system development - A status report
[AIAA PAPER 91-0880] p 635 A91-40558
SAINTE-MARIE, MARTINE
The certification of the aircraft integrated propulsive system
[REPT-911-111-102] p 661 N91-23188
SAIZ, J. M. BLANCO
Nonlinear analysis of composite shear webs with holes and correlation with tests p 684 N91-24642
SAKUMA, T.
Water-cooling technique of high temperature gas turbine blade
[DE91-764238] p 681 N91-23506
SALEIN, MARIANNE
Flight mechanics/air navigation research field. A 1990 Scientific report of the German Air and Space Research Organization
[ISSN-0720-7808] p 643 N91-23103
SALIVAR, G. C.
Fatigue crack growth in monolithic titanium aluminides p 670 A91-38809
SANCHEZTARIFA, C.
Hypersonic propulsion: Past and present p 657 N91-23148
SANDNES, M.
Spot welded thermoplastic composite access door
[SME PAPER EM90-489] p 645 A91-36942
SANKAR, L. N.
Airfoil design method using the Navier-Stokes equations p 646 A91-38550
Dynamic stall of an oscillating circulation control airfoil p 617 A91-38677
Simulation of iced wing aerodynamics
[NASA-TM-104362] p 628 N91-23086
SANKAR, LAKSHMI N.
Stability of hingeless rotors in hover using three-dimensional unsteady aerodynamics p 663 A91-36358
SANS, C.
Supersonic-hypersonic inlet studies for aerospaceplane p 659 N91-23160
SARIC, WILLIAM S.
Experiments on swept-wing boundary layers p 622 A91-39932
SATO, TADASHI
Re-entry flight control of space plane using approximate perfect servo p 664 A91-37778
SCALLION, WILLIAM I.
Advanced Hypervelocity Aerophysics Facility Workshop
[NASA-CP-10031] p 669 N91-24211
SCANLON, CHARLES H.
Flight tests show potential benefits of data link as primary communication medium p 643 A91-38577
SCHADOW, K. C.
Subsonic and supersonic combustion using noncircular injectors p 674 A91-37414
SCHAEUFELE, HORST
Equation decoupling - A new approach to the aerodynamic identification of unstable aircraft p 664 A91-37773
SCHAFFNER, P.
Description, characteristics and testing of the NASA airborne radar p 638 N91-24156
SCHERRER, DOMINIQUE
Comparative study of different systems of combined cycle propulsion p 658 N91-23152
SCHETZ, JOSEPH A.
Three-dimensional finite element method analysis of turbulent flow over self-propelled slender bodies p 615 A91-37419
SCHIMMEL, MORRY L.
Helicopter in-flight stores jettison p 671 A91-39389
SCHLICKENMAIER, HERBERT
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 2
[NASA-CP-10060-PT-2] p 636 N91-24140
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 1
[NASA-CP-10060-PT-1] p 639 N91-24166
SCHMATZ, M. A.
Analysis of numerical solutions for three-dimensional lifting wing flows p 625 A91-40498
SCHNEIDER, W.
Small Engine Component Technology (SECT) study. Program report
[NASA-CR-175077] p 662 N91-24204
SCHRADER, J. H.
Description, characteristics and testing of the NASA airborne radar p 638 N91-24156
SCHREIBER, OLIVIER
Aerodynamic interactions between bodies in relative motion p 629 N91-24103
SCHUERMAN, THOMAS M.
SATURN: The next generation radio for NATO p 682 N91-24475
SCHULTZ, F. J.
Radioluminescent (RL) lighting system development program
[DE91-009743] p 679 N91-23381
SCHULTZ, R. L.
Navigation, guidance, and trajectory optimization for hypersonic vehicles p 644 N91-23150
SCHWARZ, J.
Spot welded thermoplastic composite access door
[SME PAPER EM90-489] p 645 A91-36942
SEDBON, GILBERT
Accent on hypersonic p 669 A91-36625
SEGAWA, K.
Development and interaction of instabilities in the crossflow field p 622 A91-39938
SELA, N. M.
Ground resonance of a helicopter with inter-connected blades p 645 A91-36360
SELBERG, BRUCE P.
Aerodynamic characteristics of scissor-wing geometries p 624 A91-40216
SETTLES, GARY S.
Inception length to a fully developed, fin-generated, shock-wave, boundary-layer interaction p 617 A91-37842
SEWALL, WILLIAM G.
Laminar-flow wind tunnel experiments p 634 N91-24136
SEWERSKY, R. A.
Mechanical component diagnostic system
[AD-A232126] p 656 N91-23146
SHA, CHANGAN
Application of identification method of modal parameters to flight flutter test p 665 A91-40167
SHADMON, G.
Real time estimation of aircraft angular attitude
[IAITIC-87-1004] p 649 N91-23107
SHAFRANEK, D.
Handling qualities guidelines for the design of fly-by-wire flight control systems for transport aircraft p 667 N91-23119
SHAHWAN, E. J.
The design, manufacture, and test of a one-piece thermoplastic wing rib for tiltrotor aircraft
[SME PAPER EM90-665] p 645 A91-36940
SHAN, PENG
Cycle analysis for a supersonic through flow fan engine p 657 A91-38207
SHANAHAN, DENNIS F.
The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the copilot/gunner, volume 2
[AD-A232907] p 641 N91-24187
The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the copilot/gunner, volume 1
[AD-A233349] p 641 N91-24188
SHANGE, JOSEPH S.
Numerical study of hypersonic dissociated air past blunt bodies p 616 A91-37835
SHANKAR, S. R.
Designing with composites - A study of design process p 646 A91-38752
SHARKAWY, A.
Designing with composites - A study of design process p 646 A91-38752
SHAW, ROBERT J.
Engine technology challenges for a 21st century high speed civil transport
[NASA-TM-104363] p 636 N91-23098
SHE, GONGFAN
CAPP imitative system of aircraft assembly p 611 A91-37061
SHEIKH, S. I.
Navigation, guidance, and trajectory optimization for hypersonic vehicles p 644 N91-23150
SHEU, M. J.
Computation of axisymmetric slender bodies enclosing a jet efflux in pitching oscillatory motion p 618 A91-38681
SHEVARE, G. R.
Low-order panel method for internal flows p 625 A91-40225
SHI, RONGMING
Vibration problems in an aircraft design p 648 A91-40165
SHIH, C.
Unsteady flow past an airfoil pitched at constant rate p 617 A91-38679
SHIN, JAIWON
Advanced ice protection systems test in the NASA Lewis icing research tunnel
[NASA-TM-103757] p 661 N91-23183
SHIOMI, KAKUICHI
SSR signal discrimination from garbled replies p 642 A91-37121
SHKURUPII, O. K.
Characteristics of the reception by the antenna systems of a descending aircraft of signals from radio-beacon landing systems p 642 A91-37200
SHREWSBURY, G. D.
Dynamic stall of an oscillating circulation control airfoil p 617 A91-38677
SHUCH, H. PAUL
Near midair collisions as an indicator of general aviation collision risk p 635 N91-23096
SICLARI, MICHAEL J.
Euler analysis of a High-Speed Civil Transport concept at Mach 3 p 624 A91-40217
SIMPSON, M. A.
Full-scale demonstration tests of cabin noise reduction using active vibration control p 646 A91-38549
SIMS, CHESTER T.
Non metallic materials for gas turbine engines - Are they real? p 671 A91-40178
SINCLAIR, PETER C.
An airborne FLIR detection and warning system for low altitude wind shear p 637 N91-24147
SINGH, B.
Small Engine Component Technology (SECT) study
[NASA-CR-175079] p 663 N91-24208
SIRBAUGH, J. R.
Computation of inlet reference plane flow-field for a subscale free-jet forebody/inlet model and comparison to experimental data
[AD-A232101] p 680 N91-23445
SISLIAN, J. P.
Performance characteristics of hypersonic detonation wave ramjets p 659 N91-23168
SMART, ANTHONY E.
Velocity sensor for an airborne optical air data system p 655 A91-38542
SMITH, C. E.
A CFD study of jet mixing in reduced flow areas for lower combustor emissions
[NASA-TM-104411] p 661 N91-23185
SMITH, HOWARD
Crashworthiness experiments p 638 N91-24161
SMITH, ROGERS E.
Flying qualities of the X-29 forward swept wing aircraft p 651 N91-23127
SMITH, STEPHEN
The computation of induced drag with nonplanar and deformed wakes p 630 N91-24106
SOBEL, KENNETH M.
Robust eigenstructure assignment with structured state space uncertainty p 686 A91-39417
SOBIESZCZANSKI-SOBIESKI, JAROSLAW
A system approach to aircraft optimization
[NASA-TM-104074] p 654 N91-24196
SOBOTA, MARK S.
B-1B high AOA testing in the evaluation of a stall inhibitor system p 651 N91-23126
SOURISSEAU, J. C.
Validation of in-house and external software systems at Aerospatiale p 687 N91-24640
SOVA, G.
Aerodynamic preliminary analysis system 2. Part 2: User's manual
[NASA-CR-182077] p 627 N91-23081
SPACHT, L.
Aerodynamic preliminary analysis system 2. Part 2: User's manual
[NASA-CR-182077] p 627 N91-23081
SPALART, P. R.
Direct numerical study of crossflow instability p 678 A91-39956
SRIDHAR, J. K.
Application of multiple-input/single-output analysis procedures to flight test data p 647 A91-39420

SRIVASTAVA, RAKESH
An efficient hybrid scheme for the solution of rotational flow around advanced propellers p 629 N91-24104
STACK, JOHN P.
Laminar-flow wind tunnel experiments p 634 N91-24136
STALLARD, DAVID V.
Angle-only tracking filter in modified spherical coordinates p 643 A91-39433
STAUTER, R. C.
Temporally and spatially resolved flow in a two-stage axial compressor. II - Computational assessment [ASME PAPER 90-GT-299] p 620 A91-39048
STEINBACH, D.
A model for the experimental study of curvature effects on transition of the boundary layer on a swept wing - Preliminary results p 620 A91-39691
STEINBERG, BERNARD D.
Relative effectiveness of 2-D vs. 1-D high resolution microwave imageing p 641 A91-37094
STEINHARDT, E.
A general method for rotordynamic analysis p 677 A91-39585
STEPHENS, ROBERT L.
A test of the American Safety Flight Systems, Inc. prebreather/portable oxygen system [AD-A232723] p 636 N91-23100
STIX, GARY
Along for the ride? p 656 A91-40550
STOLLERY, J. L.
The performance of 60 deg delta wings: The effects of leading edge radius on vortex flaps and the wing [CRANFIELD-AERO-9004] p 628 N91-23092
The performance of 60 deg delta wings: The effects of leading edge radius and vortex flaps [CRANFIELD-AERO-9002] p 653 N91-23140
Some aspects of shock-wave boundary layer interaction relevant to intake flows p 628 N91-23161
STONOR, THOMAS
Air traffic control today and tomorrow p 642 A91-38215
STORM, MARK
Status of 2 micron laser technology program p 637 N91-24143
STORTZ, MICHAEL W.
Simulation evaluation of a speed-guidance law for Harrier approach transitions [NASA-TM-102853] p 668 N91-24209
STRAZISAR, ANTHONY J.
Enhancing aeropropulsion research with high-speed interactive computing [NASA-TM-104374] p 687 N91-24796
STRICKER, JEFFREY M.
Turbojet potential for hypersonic flight p 658 N91-23155
STRICKLAND, J. H.
A vortex panel method for calculating aircraft downwash on parachute trajectories [AIAA PAPER 91-0875] p 626 A91-40557
A vortex panel method for calculating aircraft downwash on parachute trajectories [DE91-009764] p 627 N91-23085
STUCKE, MONICA A.
Titanium aluminides for aerospace applications p 671 A91-39302
STURDIVANT, VERNON R.
Automatic aircraft paint stripping [SME PAPER MS90-280] p 611 A91-36895
STURGESS, G. J.
Coolant side heat transfer with rotation. Task 3 report: Application of computational fluid dynamics [NASA-CR-182109] p 683 N91-24551
SU, T. Y.
A general multiblock Euler code for propulsion integration. Volume 1: Theory document [NASA-CR-187484-VOL-1] p 632 N91-24120
A general multiblock Euler code for propulsion integration. Volume 2: User guide for BCON, pre-processor for grid generation and GMBE [NASA-CR-187484-VOL-2] p 632 N91-24121
A general multiblock Euler code for propulsion integration. Volume 3: User guide for the Euler code [NASA-CR-187484-VOL-3] p 632 N91-24122
SUDHAKAR, K.
Low-order panel method for internal flows p 625 A91-40225
SUGIMOTO, TAKESHI
Analysis of circular elastic membrane wings p 625 A91-40472
SUNDARAM, P.
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 1: Steady [AD-A233482] p 631 N91-24113
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 2: User manual for VORSTAB-2 [AD-A233483] p 631 N91-24114
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 3: Unsteady [AD-A233569] p 631 N91-24115
SUNDBERG, W. D.
A vortex panel method for calculating aircraft downwash on parachute trajectories [AIAA PAPER 91-0875] p 626 A91-40557
Low Altitude High Speed Cargo Parachute system development - A status report [AIAA PAPER 91-0880] p 635 A91-40558
A vortex panel method for calculating aircraft downwash on parachute trajectories [DE91-009764] p 627 N91-23085
SUZUKI, S.
ACT wind-tunnel experiments of a transport-type wing p 615 A91-37772
SUZUKI, SHINJI
Modeling for unsteady aerodynamics of rectangular wing in incompressible flow using step responses p 625 A91-40473
SWAFFORD, TIMOTHY W.
Euler flow predictions for an oscillating cascade using a high resolution wave-split scheme [NASA-TM-104377] p 630 N91-24107
SWANSON, D. E.
Development and demonstration of CREST subsystems p 646 A91-39380
SWANSON, G. A.
Notched fatigue of single crystal PWA 1480 at turbine attachment temperatures p 682 N91-24310
SWANSON, R. C.
Cell centered and cell vertex multigrid schemes for the Navier-Stokes equations p 674 A91-37834
SZUCH, JOHN R.
Enhancing aeropropulsion research with high-speed interactive computing [NASA-TM-104374] p 687 N91-24796

T

TAIRA, SHINICHI
High gain airborne antenna for satellite communications p 643 A91-39776
TAKAI, MASAMI
A new architecture and expert system for aircraft design synthesis p 652 N91-23132
TAKEZAWA, IEHISA
NKK premium quality titanium master alloy p 672 A91-40425
TALIA, JORGE E.
Feasibility study in crack detection in aircraft stiffened panels by pulse probing and deconvolution p 654 N91-24158
Mechanical paint removal techniques for composite aircraft p 613 N91-24163
TALPALLIKAR, M. V.
A CFD study of jet mixing in reduced flow areas for lower combustor emissions [NASA-TM-104411] p 661 N91-23185
TANAKA, MASATO
High gain airborne antenna for satellite communications p 643 A91-39776
TAO, DEPING
Cycle analysis for a supersonic through flow fan engine p 657 A91-38207
TAPOSU, I.
The influence of altitude and speed variations over the aircraft flight control response during the longitudinal nonlinear manoeuvres p 664 A91-36722
TARARYKIN, O. I.
The experimental investigation of stability and receptivity of a swept-wing flow p 623 A91-39944
TARG, RUSSELL
Coherent lidar airborne windshear sensor - Performance evaluation p 655 A91-39873
CLASS: Coherent Lidar Airborne Shear Sensor. Windshear avoidance [LMSC-F-415048] p 636 N91-24141
TAT, V. V.
Correlation of boundary layer stability analysis with flight transition data p 621 A91-39929
TCHOUBINEH, A.
Model for IR sensor performance evaluation - Applications and results p 656 A91-39890
TEN HAVE, J. M.
European studies to investigate the feasibility of using 1000 ft vertical separation minima above FL 290. I p 642 A91-38217
THANGJITHAM, SUROT
Analytical studies on static aeroelastic behavior of forward-swept composite wing structures p 674 A91-37774
THOMAS, DIETER
The art of flying qualities testing p 649 N91-23109
THOMAS, RICHARD W.
The handling qualities of the STOL and maneuver technology demonstrator from specification to flight test p 666 N91-23117
THOMAS, RUSSELL H.
Three-dimensional finite element method analysis of turbulent flow over self-propelled slender bodies p 615 A91-37419
THOMPSON, JOHN R.
The introduction of off-line programming techniques for the robotic assembly of aircraft structures [SME PAPER MS90-276] p 611 A91-36898
TILMANN, CARL P.
The effects on aerodynamic performance of designing supersonic wings for laminar flow control [AD-A233040] p 654 N91-24197
TIMME, ADALBERT
Flight mechanics/air navigation research field. A 1990 Scientific report of the German Air and Space Research Organization [ISSN-0720-7808] p 643 N91-23103
TIMOFEEV, V. A.
Boundary layer control by a local heating of the wall p 678 A91-39909
TIMOFEEVA, T. V.
Detection of traces of water in aviation kerosenes by gas chromatography p 670 A91-37182
TOBAK, M.
Asymmetric vortices on a slender body of revolution p 616 A91-37827
TOKUMARU, P. T.
Rotary oscillation control of a cylinder wake p 620 A91-39708
TOMPKINS, J. A.
Radioluminescent (RL) lighting system development program [DE91-009743] p 679 N91-23381
TOWNSEND, D. P.
Modal analysis of multistage gear systems coupled with gearbox vibrations [NASA-TM-103797] p 681 N91-23513
TOWNSEND, JAMES C.
Secondary frequencies in the wake of a circular cylinder with vortex shedding p 620 A91-39736
TRAVERSE, PASCAL
The electrical flight control system of A320 Airbus: A fault tolerant system [REPT-911-111-103] p 667 N91-23192
TRAYBAR, JOSEPH J.
Determination of decision-height windows for decelerating IMC approaches in helicopters p 667 N91-23124
TRENT, WILLIAM
National airspace system. Communications operational concept NAS-SR-136 [DOT/FAA/SE-91/1] p 640 N91-24185
TRUSCOTT, P. R.
Surface activation of Concorde by Be-7 p 690 N91-24983
TSENG, VINCENT Y.
Fire detection system for aircraft cargo bays p 655 A91-36755
TU, Y. K.
Modal analysis of multistage gear systems coupled with gearbox vibrations [NASA-TM-103797] p 681 N91-23513
TURK, M.
Small Engine Component Technology (SECT) [NASA-CR-175078] p 662 N91-24205
TYSON, KAREN W.
The costs and benefits of aircraft availability [AD-A232660] p 613 N91-23076

U

UEDA, T.
ACT wind-tunnel experiments of a transport-type wing p 615 A91-37772
USUI, H.
Research on aerodynamic control of blade tip clearance flow in air-cooled turbine [DE91-764223] p 660 N91-23182

V

V'IUNOV, SERGEI A.
Design and development of aviation gas turbine engines p 657 A91-39201

VACZY, C. M.
Deep stall of an NACA 0012 airfoil induced by periodic aerodynamic interference p 619 A91-38699
VAN DAM, C. P.
Aerodynamic characteristics of crescent and elliptic wings at high angles of attack p 624 A91-40219
VAN DOMMELEN, L.
Unsteady flow past an airfoil pitched at constant rate p 617 A91-38679
VAN STONE, R. H.
Application of path-independent integrals to elevated temperature crack growth p 671 A91-38819
VANDULLEMEN, H. A.
Evaluation of the qualification of the structure of a passenger aircraft by analysis and full-scale testing p 684 N91-24645
VANECK, T.
Unsteady aerodynamic loading of delta wings for low and high angles of attack p 617 A91-38680
VANENGELEN, J. A. J.
Handling qualities guidelines for the design of fly-by-wire flight control systems for transport aircraft p 667 N91-23119
VANGEL, MARK G.
Model sensitivity in stress-strength reliability computations
[AD-A232023] p 681 N91-23554
VANGERPEN, JON
Simulation of a combined-cycle engine
[NASA-CR-188232] p 683 N91-24583
VANKA, S. P.
Numerical study of twin-jet impingement upwash flow p 619 A91-38736
VEMURU, C. S.
Blunt-nosed swept supercritical LFC wings without nose flaps p 622 A91-39936
VENKATAKRISHNAN, V.
Implicit solvers for unstructured meshes
[NASA-CR-187564] p 633 N91-24125
VENKAYYA, V. B.
Analytical certification of aircraft structures p 684 N91-24641
VERAAR, R. G.
Theoretical and experimental performance of a solid fuel ramjet combustion cycle for hypersonic flight conditions p 660 N91-23170
VICROY, DAN D.
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 2
[NASA-CP-10060-PT-2] p 636 N91-24140
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 1
[NASA-CP-10060-PT-1] p 639 N91-24166
Estimate of heavy rain performance effect p 640 N91-24182
VIGNAU, F.
Boundary layer tripping in supersonic flow p 623 A91-39960
VIJGEN, P. M. H. W.
Aerodynamic characteristics of crescent and elliptic wings at high angles of attack p 624 A91-40219
VIKEN, J.
On the stability of swept wing laminar boundary layers including curvature effects p 622 A91-39933
VISBAL, M. R.
On some physical aspects of airfoil dynamic stall p 618 A91-38686
VISSER, KENNETH D.
Breaking down the delta wing vortex: The role of vorticity in the breakdown process
[NASA-CR-188235] p 630 N91-24109
An experimental analysis of critical factors involved in the breakdown process of leading edge vortex flows
[NASA-CR-188231] p 631 N91-24110
VOGEL, MARTIN G.
Simulation of G(x) forces using horizontal impulse accelerators p 668 A91-39396
VONGRUENHAGEN, WOLFGANG
Handling qualities evaluation for highly augmented helicopters p 651 N91-23128
VORACEK, DAVID F.
Buffet induced structural/flight-control system interaction of the X-29A aircraft
[NASA-TM-101735] p 652 N91-23133
VOSS, RALPH
The propagation of acoustic disturbances in the transonic flow fields of wings
[ESA-TT-1126] p 689 N91-23854
VRCKOVNIK, GARY
406 MHz ELT signal spectra for Sarsat p 643 A91-39778

W

WACHSPRESS, D. A.
Optimization of rotor performance in hover using a free wake analysis p 646 A91-38548
WAGGONER, E. G.
Computational support of the X-29A Advanced Technology Demonstrator flight experiment p 653 N91-24137
WAGNER, R. D.
Correlation of boundary layer stability analysis with flight transition data p 621 A91-39929
On the stability of swept wing laminar boundary layers including curvature effects p 622 A91-39933
WAGNER, RICHARD D.
Laminar-flow flight experiments p 634 N91-24135
Evaluation of cloud detection instruments and performance of laminar-flow leading-edge test articles during NASA Leading-Edge Flight-Test Program
[NASA-TP-2888] p 655 N91-24199
WALCHLI, LAWRENCE A.
Flying qualities of the X-29 forward swept wing aircraft p 651 N91-23127
WALKER, M. J.
A review of high angle of attack requirements for combat aircraft p 651 N91-23130
WANG, BAOLU
Prediction of test spectrum for gunfire vibration p 666 A91-40175
WANG, FENGSHAN
Identification of nacelle modes from airplane GVT results p 648 A91-40170
WANG, QIAN-XI
Flow around an unsteady thin wing close to curved ground p 620 A91-39744
WANG, RUOSONG
Some analysis of decision-making in the test manufacture of military aircraft
[AD-A233111] p 613 N91-24093
WANG, YUREN
Experimental investigation on supersonic combustion p 657 A91-38203
WANIE, K. M.
Analysis of numerical solutions for three-dimensional lifting wing flows p 625 A91-40498
WARDWELL, DOUGLAS A.
Suckdown, fountain lift, and pressures induced on several tandem jet V/STOL configurations
[NASA-TM-102817] p 630 N91-24108
WATKINS, JOHN W.
Deployment optimization and human factors considerations for low-altitude troop parachutes
[AIAA PAPER 91-0889] p 635 A91-40559
WATTS, MICHAEL E.
ALDAS user's manual
[NASA-TM-102831] p 687 N91-24757
WEINGOLD, HARRIS D.
Experimental investigation of loading effects on compressor trailing-edge flowfields p 615 A91-37420
WEN, JIAN
The nonlinear dynamic response analysis of the front windshield of Y12 under 'bird-impact' loads p 648 A91-40158
WENIGER, RICHARD J.
Robotic sensors for aircraft paint stripping
[SME PAPER MS90-282] p 673 A91-36896
WENTZ, WILLIAM H.
Program plans for aviation safety research
[NIAR-90-32] p 638 N91-24157
WERLE, H.
Quantitative analysis of flow visualizations in ONERA water tunnels p 677 A91-39694
WEYER, THOMAS H.
Activities report of the DLR
[ISSN-0938-2194] p 691 N91-24086
WEYH, BERNHARDT
Preference for an inertial degree of freedom describing the teeter motion of windturbine and helicopter rotors p 679 A91-40239
WHALEN, THOMAS J.
Improved silicon carbide for advanced heat engines
[NASA-CR-182289] p 672 N91-24451
WHEELER, CRAIG
Ejection seat rocket catapult design for reduced G field influence p 646 A91-39385
WHITE, DEWEY W., JR.
Literature review on geotextiles to improve pavements for general aviation airports
[AD-A232871] p 669 N91-23199
WHITE, RICHARD P., JR.
Simulation of G(x) forces using horizontal impulse accelerators p 668 A91-39396
WICHMANN, G.
Forward sweep - A favorable concept for a laminar flow wing p 615 A91-37767
WIEGAND, H.
Aerodynamics and stabilization of combustion of hydrogen jets injected into subsonic airflow p 629 N91-23164
WILHELM, KNUT
Evaluation techniques for highly augmented aircraft
[DLR-FB-90-35] p 667 N91-23191
WILLIAMS, D. R.
Forebody vortex control with the unsteady bleed technique p 617 A91-37859
WILLIAMS, J. C., III
Unsteady separation on an impulsively set into motion Carafoli airfoil p 618 A91-38694
WILLIAMS, KATHERINE A.
Titanium aluminides for aerospace applications p 671 A91-39302
WILLIS, EDWARD A.
NASA aeropropulsion research in support of propulsion systems of the 21st century
[NASA-TM-104403] p 627 N91-23083
WILSON, K. J.
Subsonic and supersonic combustion using noncircular injectors p 674 A91-37414
WITCOFSKI, ROBERT D.
Advanced Hypervelocity Aerophysics Facility Workshop
[NASA-CP-10031] p 669 N91-24211
WOLF, D. F.
A dynamic analysis of the SRB parachute system
[AIAA PAPER 91-0838] p 670 A91-40555
WOLF, STEPHEN D.
Development of a quiet supersonic wind tunnel with a cryogenic adaptive nozzle
[NASA-CR-186769] p 669 N91-23195
WONG, T.-C.
Numerical simulation of steady and unsteady asymmetric vortical flow p 618 A91-38683
WOODS, E. J.
Advanced aircraft secondary power system design p 656 A91-38007
Aircraft electrical system computer simulation p 657 A91-38037
WOODSON, SHAWN H.
Interactive three-dimensional boundary-layer method for transonic flow over swept wings p 616 A91-37829
WRENN, GREGORY A.
Application of multidisciplinary optimization methods to the design of a supersonic transport
[NASA-TM-104073] p 652 N91-23135
WRIGHT, KENNETH D., II
A field-deployable digital acoustic measurement system p 689 N91-24078
WU, ZHANG
Synchronous iterative method for computation of vortex flows at high angles of attack p 624 A91-40126
WUENNENBERG, HORST
Handling qualities of highly augmented unstable aircraft summary of an AGARD-FMP working group effort p 666 N91-23116
WULFF, G.
Application of multiple-input/single-output analysis procedures to flight test data p 647 A91-39420

X

XU, GUANGQI
Integration of vibration test and flutter analysis - A brief introduction to 'a real-time flutter analysis system' p 665 A91-40168
XU, JIADONG
The planar elements method for computing the scattering field of flight vehicle p 674 A91-37052
XU, JIANKANG
The transient dynamic performances of a rotor-SFDB system during passage through resonance p 678 A91-40130
XUE, Y.
Acoustics of unsteady transonic flow p 687 A91-38688
A study of the noise mechanisms of transonic blade-vortex interactions
[NASA-CR-188199] p 627 N91-23084

Y

YADLIN, YORAM
Block multigrid implicit solution of the Euler equations of compressible fluid flow p 616 A91-37836
Block implicit multigrid solution of the Euler equations p 680 N91-23413
YAMAMOTO, YUZO
Aerodynamic characteristics of slender wing-gap-body combinations p 615 A91-37777

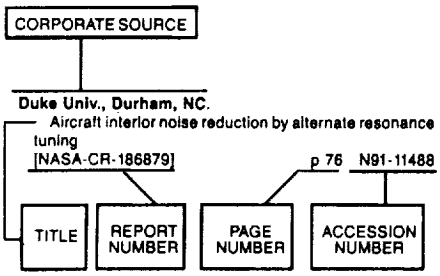
YANG, J.-S.
Design of aircraft wings subjected to gust loads - A safety index based approach p 675 A91-37851
YANG, JUEMIN
Numerical analysis of solid-fuel interactive vibration on an aircraft integral tank p 648 A91-40161
YANG, LIXIN
Experimental investigation on supersonic combustion p 657 A91-38203
YANG, S. Y.
Numerical investigation of airfoil/jet/fuselage-undersurface flowfields in ground effect p 617 A91-38541
YAO, YUFENG
Transonic flutter analysis of 2-D airfoils with 2 degrees of freedom p 665 A91-40169
YASUHARA, MICHIRU
A comparison between computation and experiment for flows around airfoil with slat and flap p 616 A91-37780
YEAGLEY, S. R.
Automated CAD design for sculptured airfoil surfaces [SME PAPER MS90-744] p 673 A91-36943
YOKOMIZO, T.
Moving surface boundary-layer control as applied to two-dimensional airfoils p 615 A91-37768
YOUNG, RONALD
Evaluation of cloud detection instruments and performance of laminar-flow leading-edge test articles during NASA Leading-Edge Flight-Test Program [NASA-TP-2888] p 655 N91-24199
YU, N. Y.
Developing and utilizing an Euler computational method for predicting the airframe/propulsion effects for an aft-mounted turboprop transport. Volume 1: Theory document [NASA-CR-181924-VOL-1] p 632 N91-24118
Developing and utilizing an Euler computational method for predicting the airframe/propulsion effects for an aft-mounted turboprop transport. Volume 2: User guide [NASA-CR-181924-VOL-2] p 632 N91-24119
YU, WANGLING
Robust eigenstructure assignment with structured state space uncertainty p 686 A91-39417

Z

ZAKRAJSEK, J. J.
Modal analysis of multistage gear systems coupled with gearbox vibrations [NASA-TM-103797] p 681 N91-23513
ZARUBIN, V. A.
Sensitivity analysis, optimization, and data support in finite element systems p 677 A91-39230
ZEINER, P.
Small Engine Component Technology (SECT) [NASA-CR-175078] p 662 N91-24205
ZHEREBTSOV, V. L.
Detection of traces of water in aviation kerosenes by gas chromatography p 670 A91-37182
ZHOU, XINHAI
Computation of three-dimensional flow fields through compressor blade rows p 625 A91-40375
ZHOU, ZHILUN
Calculation and experimental study on sonic fatigue life of aircraft structural panels p 648 A91-40162
ZHU, ZIQIANG
Transonic analysis and design using an improved grid p 624 A91-40137
ZIEMIANSKI, JOSEPH A.
NASA aeropropulsion research in support of propulsion systems of the 21st century [NASA-TM-104403] p 627 N91-23083
ZILBERMAN, M.
IAI hypersonic wind tunnel [IAITIC-87-1006] p 668 N91-23194
ZILLIAC, G. G.
Asymmetric vortices on a slender body of revolution p 616 A91-37827
ZWEIFIL, TERRY
Temperature lapse rate as an adjunct to wind shear detection p 640 N91-24184

CORPORATE SOURCE INDEX

Typical Corporate Source Index Listing



Listings in this index are arranged alphabetically by corporate source. The title of the document is used to provide a brief description of the subject matter. The page number and the accession number are included in each entry to assist the user in locating the abstract in the abstract section. If applicable, a report number is also included as an aid in identifying the document.

A

Advanced Technologies, Inc., Newport News, VA.
Soft hub for bearingless rotors
[NASA-CR-177586] p 654 N91-24198
Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
Flying Qualities
[AGARD-CP-508] p 649 N91-23108
Hypersonic Combined Cycle Propulsion
[AGARD-CP-479] p 657 N91-23147
AGARD highlights 91/1, March 1991
[AGARD-HIGHLIGHTS-91/1] p 691 N91-24084
Analytical Qualification of Aircraft Structures
[AGARD-R-772] p 683 N91-24638
AGARD flight test techniques series. Volume 9: Aircraft exterior noise measurement and analysis techniques
[AGARD-AG-300-VOL-9] p 689 N91-24843
Aeritalia S.p.A., Turin (Italy).
Flying qualities experience on the AMX aircraft
p 650 N91-23112
Aerojet TechSystems Co., Sacramento, CA.
Design considerations for combined air breathing-rocket propulsion systems
[AIAA-90-0098] p 659 N91-23158
Aeronautical Research Inst. of Sweden, Stockholm.
Long time measurements of landing gear loads on SAAB SF-340 commuter aircraft
[FFA-TN-1990-53] p 653 N91-23138
Aeronautical Systems Div., Wright-Patterson AFB, OH.
Do civil flying qualities requirements address military missions for off-the-shelf procurement
p 650 N91-23115
Aerospatiale, Toulouse (France).
Integration of propulsive systems: Selection and compromise
[REPT-911-111-101] p 661 N91-23187
The certification of the aircraft integrated propulsive system
[REPT-911-111-102] p 661 N91-23188
The electrical flight control system of A320 Airbus: A fault tolerant system
[REPT-911-111-103] p 667 N91-23192
Observatory of new materials. Evolution perspectives for the materials used in civil transportation aircraft
[REPT-911-111-107] p 672 N91-23248
Noise inside aircraft fuselages subjected to airborne excitations
[REPT-911-111-104] p 689 N91-23853
Validation of in-house and external software systems at Aerospatiale p 687 N91-24640
Aerospatiale Aquitaine, Saint-Medard en Jalles (France).
Oxidation resistant carbon/carbon materials
[REPT-911-430-105] p 672 N91-23251
How to know CMC
[REPT-911-430-130] p 672 N91-23262
Air Force Flight Dynamics Lab., Wright-Patterson AFB, OH.
MIL-STD-1797 is not a cookbook p 650 N91-23111
The effects on aerodynamic performance of designing supersonic wings for laminar flow control
[AD-A233040] p 654 N91-24197
Air Force Systems Command, Wright-Patterson AFB, OH.
Some analysis of decision-making in the test manufacture of military aircraft
[AD-A233111] p 613 N91-24093
Design and implementation of real-time computer coordinated force actuating system with multi-input/output
[AD-A233114] p 687 N91-24768
Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH.
Three-dimensional composite velocity solutions for subsonic/transonic flow p 616 A91-37841
Analytical Services and Materials, Inc., Hampton, VA.
On the stability of swept wing laminar boundary layers including curvature effects p 622 A91-39933
Blunt-nosed swept supercritical LFC wings without nose flaps p 622 A91-39936
Arizona State Univ., Tempe.
Experiments on swept-wing boundary layers
p 622 A91-39932
Army Aeromedical Research Lab., Fort Rucker, AL.
A test of the American Safety Flight Systems, Inc. prebreather/portable oxygen system
[AD-A232723] p 636 N91-23100
The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the copilot/gunner, volume 2
[AD-A232907] p 641 N91-24187
The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the copilot/gunner, volume 1
[AD-A233349] p 641 N91-24188
Army Aviation Systems Command, Cleveland, OH.
Effects of inlet distortion on the development of secondary flows in a subsonic axial inlet compressor rotor
[NASA-TM-104356] p 660 N91-23179
Small Engine Component Technology (SECT) study
[NASA-CR-175079] p 663 N91-24208
Army Engineer Waterways Experiment Station, Vicksburg, MS.
Analytical study of the effects of weight on Light Helicopter (LH) exposure to ground-based weapons
[AD-A232024] p 653 N91-23141
Literature review on geotextiles to improve pavements for general aviation airports
[AD-A232871] p 669 N91-23199
Army Lab. Command, Watertown, MA.
Model sensitivity in stress-strength reliability computations
[AD-A232023] p 681 N91-23554
Arnold Engineering Development Center, Arnold Air Force Station, TN.
Computation of inlet reference plane flow-field for a subscale free-jet forebody/inlet model and comparison to experimental data
[AD-A232101] p 680 N91-23445
Avco Lycoming Div., Stratford, CT.
Small Engine Component Technology (SECT) study. Program report
[NASA-CR-175077] p 662 N91-24204

B

Beech Aircraft Corp., Wichita, KS.
Beechcraft starship strength certification
p 684 N91-24643
Bell Helicopter Co., Fort Worth, TX.
Airfoil design method using the Navier-Stokes equations p 646 A91-38550
Boeing Commercial Airplane Co., Seattle, WA.
Aircraft Command in Emergency Situations (ACES). Phase 1: Concept development
[DOT/FAA/CT-90/21] p 636 N91-23097
Developing and utilizing an Euler computational method for predicting the airframe/propulsion effects for an aft-mounted turboprop transport. Volume 1: Theory document
[NASA-CR-181924-VOL-1] p 632 N91-24118
Developing and utilizing an Euler computational method for predicting the airframe/propulsion effects for an aft-mounted turboprop transport. Volume 2: User guide
[NASA-CR-181924-VOL-2] p 632 N91-24119
A general multiblock Euler code for propulsion integration. Volume 1: Theory document
[NASA-CR-187484-VOL-1] p 632 N91-24120
A general multiblock Euler code for propulsion integration. Volume 2: User guide for BCON, pre-processor for grid generation and GMBE
[NASA-CR-187484-VOL-2] p 632 N91-24121
A general multiblock Euler code for propulsion integration. Volume 3: User guide for the Euler code
[NASA-CR-187484-VOL-3] p 632 N91-24122
Variable Sweep Transition Flight Experiment (VSTFE): Unified Stability System (USS). Description and users' manual
[NASA-CR-181918] p 634 N91-24139
Environmental exposure effects on composite materials for commercial aircraft
[NASA-CR-187478] p 672 N91-24358
Boeing Military Airplane Development, Wichita, KS.
Water droplet impingement on airfoils and aircraft engine inlets for icing analysis p 634 A91-38543
British Aerospace Public Ltd. Co., Preston (England).
The development of alternate criteria for FBW handling qualities p 666 N91-23113
A review of high angle of attack requirements for combat aircraft p 651 N91-23130
Brown Univ., Providence, RI.
Secondary frequencies in the wake of a circular cylinder with vortex shedding p 620 A91-39736

C

Cairo Univ. (Egypt).
Heat transfer in oscillating flows p 676 A91-38698
California Inst. of Tech., Pasadena.
Simulation of the flow past an impulsively started cylinder using a discrete vortex method
[AD-A233066] p 683 N91-24533
California Univ., Berkeley.
Interferometric investigation of supersonic flow fields with shock-shock interactions p 627 N91-23082
Near midair collisions as an indicator of general aviation collision risk p 635 N91-23096
California Univ., Davis.
Identification of pilot-vehicle dynamics from simulation and flight test p 664 A91-37598
Aerodynamic characteristics of crescent and elliptic wings at high angles of attack p 624 A91-40219

California Univ., Los Angeles.
Euler calculations of unsteady transonic flow in cascades
[AIAA PAPER 91-1104] p 626 A91-40562
Integrated multidisciplinary optimization of actively controlled fiber composite wings p 667 N91-23190
Calspan Advanced Technology Center, Buffalo, NY.
The flying qualities influence of delay in the fighter pilot's cuing environment p 650 N91-23120
Canadair Ltd., Montreal (Quebec).
The role of analysis in the design and qualification of composite aircraft structures p 684 N91-24648
Central Research Inst. of Electric Power Industry, Tokyo (Japan).
Water-cooling technique of high temperature gas turbine blade
[DE91-764238] p 681 N91-23506
Cincinnati Univ., OH.
Three-dimensional composite velocity solutions for subsonic/transonic flow p 616 A91-37841
Analysis and control of low-speed forced unsteady flow p 676 A91-38697
Clemson Univ., SC.
Signal processing techniques for clutter filtering and wind shear detection p 638 N91-24154
Coherent Technologies, Inc., Boulder, CO.
Coherent lidar airborne windshear sensor - Performance evaluation p 655 A91-39873
Colorado State Univ., Fort Collins.
An airborne FLIR detection and warning system for low altitude wind shear p 637 N91-24147
Computer Resource Management, Inc., Herndon, VA.
National airspace system. Communications operational concept NAS-SR-136
[DOT/FAA/SE-91/1] p 640 N91-24185
Construcciones Aeronauticas S.A., Madrid (Spain).
Nonlinear analysis of composite shear webs with holes and correlation with tests p 684 N91-24642
Continuum Dynamics, Inc., Princeton, NJ.
Optimization of rotor performance in hover using a free wake analysis p 646 A91-38548
Cornell Univ., Ithaca, NY.
Block implicit multigrid solution of the Euler equations p 680 N91-23413
Cranfield Inst. of Tech., Bedford (England).
The performance of 60 deg delta wings: The effects of leading edge radius on vortex flaps and the wing
[CRANFIELD-AERO-9004] p 628 N91-23092
The performance of 60 deg delta wings: The effects of leading edge radius and vortex flaps
[CRANFIELD-AERO-9002] p 653 N91-23140
Some aspects of shock-wave boundary layer interaction relevant to intake flows p 628 N91-23161

D

Dassault-Breguet Aviation, Saint Cloud (France).
Influence of the refinement of structural calculation on aircraft qualification procedures p 684 N91-24649
Dayton Univ., OH.
Hypersonic aerodynamics fellowships
[AD-A233584] p 632 N91-24116
Department of Transportation, Cambridge, MA.
Aircraft wake vortices: An annotated bibliography (1923-1990)
[AD-A233161] p 631 N91-24111
Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.).
Cell centered and cell vertex multigrid schemes for the Navier-Stokes equations p 674 A91-37834
Development of MIL-8785C into a handling qualities specification for a new European fighter aircraft p 666 N91-23114
Handling qualities evaluation for highly augmented helicopters p 651 N91-23128
Evaluation techniques for highly augmented aircraft
[DLR-FB-90-35] p 667 N91-23191
Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.).
Flight mechanics/air navigation research field. A 1990 Scientific report of the German Air and Space Research Organization
[ISSN-0720-7808] p 643 N91-23103
The limits of the landing process of aircraft
[DLR-FB-90-49] p 653 N91-23137
Trajectory optimization considerations for ramjet engines p 658 N91-23151
Aerodynamics and stabilization of combustion of hydrogen jets injected into subsonic airflow p 629 N91-23164
Activities report of the DLR
[ISSN-0938-2194] p 691 N91-24086
Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen (Germany, F.R.).
Procedure for determination of three-dimensional wind tunnel wall interferences and wall adaptation in compressible subsonic flow using measured wall pressures
[DLR-FB-90-46] p 628 N91-23088
Dornier System G.m.b.H., Friedrichshafen (Germany, F.R.).
Handling qualities of highly augmented unstable aircraft summary of an AGARD-FMP working group effort p 666 N91-23116
Integration of handling quality aspects into the aerodynamic design of modern unstable fighters p 667 N91-23125
Douglas Aircraft Co., Inc., Long Beach, CA.
The 1989 high-speed civil transport studies
[NASA-CR-4375] p 654 N91-24195

E

European Space Agency, Paris (France).
The propagation of acoustic disturbances in the transonic flow fields of wings
[ESA-TT-1126] p 689 N91-23854
Exeter Univ. (England).
On the Goertler vortex instability mechanism at hypersonic speeds p 623 A91-39940

F

Federal Aviation Administration, Atlantic City, NJ.
Differential GPS terminal area test results
[AD-A232668] p 644 N91-23106
An investigation into the use of side-arm control for civil rotorcraft applications p 667 N91-23123
Determination of decision-height windows for decelerating IMC approaches in helicopters p 667 N91-23124
MLS mathematical model validation study using airborne MLS data from Atlantic City International Airport Boeing 727 elevation shadowing flight tests
[DOT-FAA/CT-TN90/55] p 644 N91-24190
Federal Aviation Administration, Cambridge, MA.
Aircraft wake vortices: An assessment of the current situation
[AD-A231658] p 626 N91-23079
Federal Aviation Administration, Washington, DC.
Precision runway monitor demonstration report
[AD-A232671] p 669 N91-23198
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 2
[NASA-CP-10060-PT-2] p 636 N91-24140
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 1
[NASA-CP-10060-PT-1] p 639 N91-24166
Aviation system capital investment plan
[PB91-150268] p 644 N91-24189
Fiat Aviazione S.p.A., Turin (Italy).
Airbreathing propulsion for transatmospheric flight p 659 N91-23156
Flight Safety Foundation, Inc., Arlington, VA.
Wind shear training applications for 91/135 p 639 N91-24173
Fokker B.V., Schipol-Oost (Netherlands).
Evaluation of the qualification of the structure of a passenger aircraft by analysis and full-scale testing p 684 N91-24645
Ford Motor Co., Dearborn, MI.
Improved silicon carbide for advanced heat engines
[NASA-CR-182289] p 672 N91-24451

G

Garrett Turbine Engine Co., Phoenix, AZ.
Small Engine Component Technology (SECT)
[NASA-CR-175078] p 662 N91-24205
General Electric Co., Cincinnati, OH.
Application of path-independent integrals to elevated temperature crack growth p 671 A91-38819
General Motors Corp., Indianapolis, IN.
Small Engine Component Technology (SECT) study
[NASA-CR-175081] p 663 N91-24207
George Washington Univ., Washington, DC.
Effects of horizontal tail ice on longitudinal aerodynamic derivatives p 665 A91-38547
Georgia Inst. of Tech., Atlanta.
Airfoil design method using the Navier-Stokes equations p 646 A91-38550
Aerodynamic interactions between bodies in relative motion p 629 N91-24103
An efficient hybrid scheme for the solution of rotational flow around advanced propellers p 629 N91-24104
Grumman Aerospace Corp., Bethpage, NY.
Euler analysis of a High-Speed Civil Transport concept at Mach 3 p 624 A91-40217

H

Hamilton Standard, Windsor Locks, CT.
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 3: Application of theory for blade loading, wakes, noise, and wing shielding
[NASA-CR-185193] p 688 N91-23850
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 4: Computer user's manual for UAAP turboprop aeroacoustic code
[NASA-CR-185194] p 688 N91-23851
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 5: Propagation of propeller tone noise through a fuselage boundary layer
[NASA-CR-185195] p 689 N91-23852
High Technology Corp., Hampton, VA.
Real gas effects on hypersonic boundary-layer stability p 614 A91-36453
Transition research in low-disturbance high-speed wind tunnels p 621 A91-39919
Correlation of boundary layer stability analysis with flight transition data p 621 A91-39929
On the stability of swept wing laminar boundary layers including curvature effects p 622 A91-39933
Blunt-nosed swept supercritical LFC wings without nose flaps p 622 A91-39936
Aerodynamic characteristics of crescent and elliptic wings at high angles of attack p 624 A91-40219
Honeywell, Inc., Minneapolis, MN.
Navigation, guidance, and trajectory optimization for hypersonic vehicles p 644 N91-23150
Honeywell, Inc., Phoenix, AZ.
Integration of weather sensing devices p 639 N91-24174
Temperature lapse rate as an adjunct to wind shear detection p 640 N91-24184

I

Illinois Univ., Urbana.
Numerical study of twin-jet impingement upwash flow p 619 A91-38736
Industrieanlagen-Betriebsgesellschaft m.b.H., Ottobrunn (Germany, F.R.).
Airbreathing propulsion for space transport: New concepts, special problems and attempts at solutions p 658 N91-23154
Institute for Computer Applications in Science and Engineering, Hampton, VA.
Second mode interactions in supersonic boundary layers p 623 A91-39957
Implicit solvers for unstructured meshes
[NASA-CR-187564] p 633 N91-24125
Institute for Defense Analyses, Alexandria, VA.
The costs and benefits of aircraft availability
[AD-A232660] p 613 N91-23076
Estimating fixed and variable costs of airframe manufacturers
[AD-A232661] p 613 N91-23077
Iowa State Univ. of Science and Technology, Ames.
Simulation of a combined-cycle engine
[NASA-CR-188232] p 683 N91-24583
Israel Aircraft Industries Ltd., Ben-Gurion Airport.
Real time estimation of aircraft angular attitude
[IAITIC-87-1004] p 649 N91-23107
IAI hypersonic wind tunnel
[IAITIC-87-1006] p 668 N91-23194
Computerized system for static and fatigue large scale structural tests: A case study
[IAITIC-87-1007] p 681 N91-23522

J

Johns Hopkins Univ., Laurel, MD.
Design techniques for dual mode ram-scramjet combustors p 659 N91-23166
Jordan Univ. of Science and Technology, Irbid.
Unsteady aerodynamic loading of delta wings for low and high angles of attack p 617 A91-38680
Visualization of the flow about a delta wing maneuvering in pitch to very high angle of attack p 618 A91-38684

L

Lehigh Univ., Bethlehem, PA.
Unsteady flow structure from swept edges subjected to controlled motion
[AD-A232714] p 628 N91-23094
Litton Aero Products, Moorpark, CA.
Avionic laser multisensor program at Litton Aero Products p 637 N91-24144
Lockheed Aeronautical Systems Co., Burbank, CA.
Laboratory test and acoustic analysis of cabin treatment for propfan test assessment aircraft
[NASA-CR-182075] p 690 N91-24844
Lockheed Engineering and Sciences Co., Hampton, VA.
Calculation of steady and unsteady pressures on wings at supersonic speeds with a transonic small-disturbance code p 617 A91-38544
Signal processing of aircraft flyover noise
[NASA-CR-187546] p 690 N91-24845
Lockheed Missiles and Space Co., Palo Alto, CA.
Coherent lidar airborne windshear sensor - Performance evaluation p 655 A91-39873
CLASS: Coherent Lidar Airborne Shear Sensor. Windshear avoidance
[LMSC-F-415048] p 636 N91-24141

M

Magnavox Co., Fort Wayne, IN.
SATURN: The next generation radio for NATO p 682 N91-24475
Massachusetts Inst. of Tech., Cambridge.
Microburst avoidance simulation tests p 639 N91-24172
Viscous design and analysis methods for transonic compressor blading
[AD-A232902] p 682 N91-24530
Massachusetts Inst. of Tech., Lexington.
Orlando experiment p 640 N91-24177
MCAT Inst., San Jose, CA.
Development of a quiet supersonic wind tunnel with a cryogenic adaptive nozzle
[NASA-CR-186769] p 669 N91-23195
McDonnell Aircraft Co., Saint Louis, MO.
Hot gas ingestion test results of a two-poster vectored thrust concept with flow visualization in the NASA Lewis 9- by 15-foot low speed wind tunnel
[AIAA PAPER 90-2268] p 626 A91-40561
McDonnell-Douglas Helicopter Co., Mesa, AZ.
ADFCS and NOTAR (trademark): Two ways to fix flying qualities p 650 N91-23110
Technology needs for high-speed rotorcraft
[NASA-CR-177578] p 652 N91-23136
Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).
X-31A at first flight p 651 N91-23131
Analytical methods for the qualification of helicopter structures p 684 N91-24650
Michigan Univ., Ann Arbor.
An experimental investigation of vortex pair interaction with a clean or contaminated free surface p 680 N91-23419
Micro Craft, Inc., Tullahoma, TN.
Unsteady Navier-Stokes solutions for a low aspect ratio delta wing
[AD-A233201] p 631 N91-24112
Minnesota Univ., Minneapolis.
A study of the noise mechanisms of transonic blade-vortex interactions
[NASA-CR-188199] p 627 N91-23084
Missouri Univ., Rolla.
Aerodynamic characteristics of scissor-wing geometries p 624 A91-40216
Mitre Corp., McLean, VA.
Thermodynamic Alerter for Microbursts (TAMP) p 640 N91-24179
Motoren- und Turbinen-Union Muenchen G.m.b.H. (Germany, F.R.).
The 2-D supersonic nozzle design p 660 N91-23176

N

National Aeronautical Establishment, Ottawa (Ontario).
An initial study into the influence of control stick characteristics on the handling qualities of a fly-by-wire helicopter p 651 N91-23122
An investigation into the use of side-arm control for civil rotorcraft applications p 667 N91-23123
Determination of decision-height windows for decelerating IMC approaches in helicopters p 667 N91-23124
National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
Effect of exhaust plume/afterbody interaction on installed scramjet performance p 615 A91-37770
Asymmetric vortices on a slender body of revolution p 616 A91-37827
Temporally and spatially resolved flow in a two-stage axial compressor. II - Computational assessment
[ASME PAPER 90-GT-299] p 620 A91-39048
Direct numerical study of crossflow instability p 678 A91-39956
Static measurements of slender delta wing rolling moment hysteresis p 625 A91-40223
Airborne rescue system
[NASA-CASE-ARC-11909-1] p 635 N91-23095
Microwave landing system modeling with application to air traffic control
[NASA-TM-102832] p 636 N91-23099
Analytical and experimental investigations of the oblique detonation wave engine concept p 660 N91-23169
The computation of induced drag with nonplanar and deformed wakes p 630 N91-24106
Suckdown, fountain lift, and pressures induced on several tandem jet V/STOL configurations
[NASA-TM-102817] p 630 N91-24108
Simulation evaluation of a speed-guidance law for Harrier approach transitions
[NASA-TM-102853] p 668 N91-24209
ALDAS user's manual
[NASA-TM-102831] p 687 N91-24757
National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
Correlation of boundary layer stability analysis with flight transition data p 621 A91-39929
Flying qualities of the X-29 forward swept wing aircraft p 651 N91-23127
Buffet induced structural/flight-control system interaction of the X-29A aircraft
[NASA-TM-101735] p 652 N91-23133
Flow visualization study of a 1/48-scale AFTI/F111 model to investigate horizontal tail flow disturbances
[NASA-TM-101698] p 633 N91-24128
Effects of wing sweep on in-flight boundary-layer transition for a laminar flow wing at Mach numbers from 0.60 to 0.79
[NASA-TM-101701] p 683 N91-24555
Effects of wing sweep on boundary-layer transition for a smooth F-14A wing at Mach numbers from 0.700 to 0.825
[NASA-TM-101712] p 683 N91-24556
National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
Real gas effects on hypersonic boundary-layer stability p 614 A91-36453
Control law synthesis and stability robustness improvement using constrained optimization techniques p 686 A91-37591
Interactive three-dimensional boundary-layer method for transonic flow over swept wings p 616 A91-37829
Cell centered and cell vertex multigrid schemes for the Navier-Stokes equations p 674 A91-37834
Study of thermal-expansion-molded, graphite-epoxy hat-stiffened sandwich panels p 675 A91-37845
Calculation of steady and unsteady pressures on wings at supersonic speeds with a transonic small-disturbance code p 617 A91-38544
Effects of horizontal tail ice on longitudinal aerodynamic derivatives p 665 A91-38547
Airfoil design method using the Navier-Stokes equations p 646 A91-38550
Flight tests show potential benefits of data link as primary communication medium p 643 A91-38577
Aeronautical research in the United States - Challenges for the 1990's p 612 A91-38580
Numerical simulation of steady and unsteady asymmetric vortical flow p 618 A91-38683
Helicopter in-flight stores jettison p 671 A91-39389
Secondary frequencies in the wake of a circular cylinder with vortex shedding p 620 A91-39736
Coherent lidar airborne windshear sensor - Performance evaluation p 655 A91-39873
Transition research in low-disturbance high-speed wind tunnels p 621 A91-39919
Correlation of boundary layer stability analysis with flight transition data p 621 A91-39929
Experiments on swept-wing boundary layers p 622 A91-39932
On the stability of swept wing laminar boundary layers including curvature effects p 622 A91-39933
Second mode interactions in supersonic boundary layers p 623 A91-39957
Euler analysis of a High-Speed Civil Transport concept at Mach 3 p 624 A91-40217
Aerodynamic characteristics of crescent and elliptic wings at high angles of attack p 624 A91-40219
Application of multidisciplinary optimization methods to the design of a supersonic transport
[NASA-TM-104073] p 652 N91-23135
Hypersonic propulsion: Status and challenge p 658 N91-23153
Passive laminar flow control of crossflow vorticity
[NASA-CASE-LAR-13563-1] p 679 N91-23410
Quantitative nondestructive evaluation: Requirements for tomorrow's reliability p 681 N91-24074
A field-deployable digital acoustic measurement system p 689 N91-24078
The NASA Langley laminar-flow-control experiment on a swept, supercritical airfoil: Suction coefficient analysis
[NASA-TM-4267] p 629 N91-24098
Transonic Symposium: Theory, Application and Experiment, volume 2
[NASA-CP-3020-VOL-2] p 634 N91-24132
National Transonic Facility status p 669 N91-24133
Reynolds number effects on the transonic aerodynamics of a slender wing-body configuration p 634 N91-24134
Laminar-flow flight experiments p 634 N91-24135
Laminar-flow wind tunnel experiments p 634 N91-24136
Computational support of the X-29A Advanced Technology Demonstrator flight experiment p 653 N91-24137
Results of correlations for transition location on a clean-up glove installed on an F-14 aircraft and design studies for a laminar glove for the X-29 aircraft accounting for spanwise pressure gradient p 654 N91-24138
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 2
[NASA-CP-10060-PT-2] p 636 N91-24140
Status of 2 micron laser technology program p 637 N91-24143
Status of NASA's IR wind shear detection research p 637 N91-24145
Clutter modeling of the Denver Airport and surrounding areas p 638 N91-24152
Airborne radar simulation studies of the Denver July 11, 1988 microburst p 638 N91-24155
Description, characteristics and testing of the NASA airborne radar p 638 N91-24156
Airborne Wind Shear Detection and Warning Systems: Third Combined Manufacturers' and Technologists' Conference, part 1
[NASA-CP-10060-PT-1] p 639 N91-24166
Integrated data analysis of July 7, 1990 microburst p 685 N91-24170
NASA Langley flight test program p 639 N91-24175
TDWR information on the flight deck p 640 N91-24176
Status of heavy rain tests p 640 N91-24180
Estimate of heavy rain performance effect p 640 N91-24182
A system approach to aircraft optimization
[NASA-TM-104074] p 654 N91-24196
Evaluation of cloud detection instruments and performance of laminar-flow leading-edge test articles during NASA Leading-Edge Flight-Test Program
[NASA-TP-2888] p 655 N91-24199
NASA-LaRc Flight-Critical Digital Systems Technology Workshop
[NASA-CP-10028] p 655 N91-24200
Advanced Hypervelocity Aerophysics Facility Workshop
[NASA-CP-10031] p 669 N91-24211
National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
Computational analysis of underexpanded jets in the hypersonic regime p 615 A91-37421
Sensor failure detection for jet engines p 656 A91-37593
Effects of horizontal tail ice on longitudinal aerodynamic derivatives p 665 A91-38547
Heat transfer in oscillating flows p 676 A91-38698
Hot gas ingestion test results of a two-poster vectored thrust concept with flow visualization in the NASA Lewis 9- by 15-foot low speed wind tunnel
[AIAA PAPER 90-2268] p 626 A91-40561
NASA aeropropulsion research in support of propulsion systems of the 21st century
[NASA-TM-104403] p 627 N91-23083
Simulation of iced wing aerodynamics
[NASA-TM-104362] p 628 N91-23086
Icing simulation: A survey of computer models and experimental facilities
[NASA-TM-104366] p 628 N91-23087
A study of three dimensional turbulent boundary layer separation and vortex flow control using the reduced Navier Stokes equations
[NASA-TM-104407] p 628 N91-23089

Engine technology challenges for a 21st century high speed civil transport
[NASA-TM-104363] p 636 N91-23098
Effects of inlet distortion on the development of secondary flows in a subsonic axial inlet compressor rotor
[NASA-TM-104356] p 660 N91-23179
Multi-heat addition turbine engine
[NASA-CASE-LEW-15094-1] p 660 N91-23180
Advanced ice protection systems test in the NASA Lewis icing research tunnel
[NASA-TM-103757] p 661 N91-23183
Model rotor icing tests in the NASA Lewis icing research tunnel
[NASA-TM-104351] p 661 N91-23184
A CFD study of jet mixing in reduced flow areas for lower combustor emissions
[NASA-TM-104411] p 661 N91-23185
Simulation of brush insert for leading-edge-passage convective heat transfer
[NASA-TM-103801] p 679 N91-23409
Modal analysis of multistage gear systems coupled with gearbox vibrations
[NASA-TM-103797] p 681 N91-23513
Euler flow predictions for an oscillating cascade using a high resolution wave-split scheme
[NASA-TM-104377] p 630 N91-24107
The 3-D Navier-Stokes analysis of crossing, glancing shocks/turbulent boundary layer interactions
[NASA-TM-104469] p 633 N91-24130
A design strategy for the use of vortex generators to manage inlet-engine distortion using computational fluid dynamics
[NASA-TM-104436] p 633 N91-24131
Static performance tests of a flight-type STOVL ejector
[NASA-TM-104437] p 662 N91-24201
Mixing of multiple jets with a confined subsonic crossflow. Summary of NASA-supported experiments and modeling
[NASA-TM-104412] p 662 N91-24202
Fuel-rich, catalytic reaction experimental results
[NASA-TM-104423] p 662 N91-24203
Average-passage flow model development
p 682 N91-24338
Probability approach for strength calculations
p 685 N91-24652
Enhancing aeropropulsion research with high-speed interactive computing
[NASA-TM-104374] p 687 N91-24796

National Aerospace Lab., Tokyo (Japan).
Research on aerodynamic control of blade tip clearance flow in air-cooled turbine
[DE91-764223] p 660 N91-23182

National Center for Atmospheric Research, Boulder, CO.
Integration of the TDWR and LLWAS wind shear detection system p 640 N91-24178

Naval Air Development Center, Warminster, PA.
Agility: A rational development of fundamental metrics and their relationship to flying qualities
p 651 N91-23129

Naval Postgraduate School, Monterey, CA.
Design and construction of a composite airframe for UAV research
[AD-A232422] p 653 N91-23143
An engineering study of altitude determination deficiencies of the Service Aircraft Instrumentation Package (SAIP)
[AD-A232055] p 656 N91-23145

New Jersey Inst. of Tech., Newark.
The stability to two-dimensional wakes and shear layers at high Mach numbers p 614 A91-36452

North Carolina State Univ., Raleigh.
Interactive three-dimensional boundary-layer method for transonic flow over swept wings p 616 A91-37829
Theoretical evaluation of engine auxiliary inlet design for supersonic V/STOL aircraft
[NASA-CR-187098] p 633 N91-24123

Notre Dame Univ., IN.
Breaking down the delta wing vortex: The role of vorticity in the breakdown process
[NASA-CR-188235] p 630 N91-24109
An experimental analysis of critical factors involved in the breakdown process of leading edge vortex flows
[NASA-CR-188231] p 631 N91-24110

O

Oak Ridge National Lab., TN.
Radioluminescent (RL) lighting system development program
[DE91-009743] p 679 N91-23381

Office National d'Etudes et de Recherches Aerospatiales, Modane (France).
A study of supersonic and hypersonic ramjet engines in France from 1950 to 1974 (application on combined cycle aircraft engines) p 658 N91-23149

Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
Compact heat exchanger for an inverse components engine p 659 N91-23157
Supersonic-hypersonic inlet studies for aerospaceplane p 659 N91-23160
LIDAR studies on microbursts p 639 N91-24167

Oklahoma Univ., Norman.
Performance of an aerospace plane propulsion nozzle
p 615 A91-37769

Old Dominion Univ., Norfolk, VA.
Numerical simulation of steady and unsteady asymmetric vortical flow p 618 A91-38683
Airfoil transition and separation studies using an infrared imaging system p 624 A91-40215
An experimental study of an axisymmetric turbulent boundary layer disturbed by a periodic freestream
p 626 N91-23078

Ophir Corp., Lakewood, CO.
Continuous wave laser for wind shear detection
p 637 N91-24142

P

Pennsylvania State Univ., University Park.
Inception length to a fully developed, fin-generated, shock-wave, boundary-layer interaction
p 617 A91-37842
Experiments on the unsteadiness associated with a ground vortex p 624 A91-40220
A computationally efficient modelling of laminar separation bubbles p 680 N91-23411
A new facility to study three dimensional viscous flow and rotor-stator interaction in turbines
p 682 N91-24336

Pisa Univ. (Italy).
Metrics for roll response flying qualities
p 650 N91-23118

Pratt and Whitney Aircraft, East Hartford, CT.
Application of cyclic damage accumulation life prediction model to high temperature components
p 681 N91-24309

Pratt and Whitney Aircraft, West Palm Beach, FL.
Coolant side heat transfer with rotation. Task 3 report: Application of computational fluid dynamics
[NASA-CR-182109] p 683 N91-24551

Prins Maurits Lab. TNO, Rijswijk (Netherlands).
Theoretical and experimental performance of a solid fuel ramjet combustion cycle for hypersonic flight conditions
p 660 N91-23170

R

Remtech, S.A., Paris (France).
MEGASODAR experiment p 639 N91-24169

Research Triangle Inst., Newport News, VA.
Radar simulation program upgrade and algorithm development p 638 N91-24153

Rockwell International Corp., Cedar Rapids, IA.
Wind Shear radar program future plans
p 637 N91-24151

Rockwell International Corp., Los Angeles, CA.
Aerodynamic preliminary analysis system 2. Part 1: Theory
[NASA-CR-182076] p 626 N91-23080
Aerodynamic preliminary analysis system 2. Part 2: User's manual
[NASA-CR-182077] p 627 N91-23081

Rome Univ. (Italy).
Reacting shock waves in hypersonic propulsion applications p 629 N91-23174

Royal Aerospace Establishment, Bedford (England).
Calculation of steady and unsteady pressures on wings at supersonic speeds with a transonic small-disturbance code p 617 A91-38544
Handling qualities guidelines for the design of fly-by-wire flight control systems for transport aircraft
p 667 N91-23119

Royal Aerospace Establishment, Farnborough (England).
Lightning protection requirements for aircraft: A proposed specification
[RAE-TM-FS(F)-632-ISSUE-1-R] p 641 N91-24186
The role of structural analysis in airworthiness certification p 684 N91-24647

Royal Aircraft Establishment, Farnborough (England).
Surface activation of Concorde by Be-7
p 690 N91-24983

S

San Diego State Univ., CA.
Unsteady aerodynamic loading of delta wings for low and high angles of attack p 617 A91-38680
Static measurements of slender delta wing rolling moment hysteresis p 625 A91-40223

Sandia National Labs., Albuquerque, NM.
A vortex panel method for calculating aircraft downwash on parachute trajectories
[DE91-009764] p 627 N91-23085
Advanced thermally stable jet fuels development program annual report. Volume 3: Fuel lubricity
[AD-A232793] p 673 N91-24453

Schimmel Co., Saint Louis, MO.
Helicopter in-flight stores jettison p 671 A91-39389

Science Applications International Corp., Fort Washington, PA.
Advanced computational models for analyzing high speed propulsive flowfields p 686 N91-24291

Sener S.A., Madrid (Spain).
Hypersonic propulsion: Past and present
p 657 N91-23148

Service Technique de la Navigation Aerienne, Paris (France).
RADAR performance experiments
p 639 N91-24168

Societe Europeenne de Propulsion, Suresnes (France).
Comparative study of different systems of combined cycle propulsion p 658 N91-23152

Sparta, Inc., Laguna Hills, CA.
National remote computational flight research facility
[NASA-CR-179432] p 668 N91-24210

Stanford Univ., CA.
Unsteady aerodynamic loading of delta wings for low and high angles of attack p 617 A91-38680
A new architecture and expert system for aircraft design synthesis p 652 N91-23132
The effects of controlling vortex formation on the performance of a dump combustor p 672 N91-23270
Nonlinear Aerodynamics and the Design of Wing Tips
[NASA-CR-188044] p 630 N91-24105

Sundstrand Data Control, Inc., Redmond, WA.
Status of Sundstrand research p 640 N91-24183

Sverdrup Technology, Inc., Arnold AFS, TN.
Computation of inlet reference plane flow-field for a subscale free-jet forebody/inlet model and comparison to experimental data
[AD-A232101] p 680 N91-23445

Sverdrup Technology, Inc., Cleveland, OH.
Computational analysis of underexpanded jets in the hypersonic regime p 615 A91-37421
Viscous three-dimensional analyses for nozzles for hypersonic propulsion p 629 N91-23175

Syracuse Univ., NY.
An isentropic compression-heated Ludweig tube transient wind tunnel p 673 A91-36450

Systems Control Technology, Inc., Arlington, VA.
Air ambulance helicopter operational analysis
[DOT/FAA/RD-91/7] p 652 N91-23134

T

Technische Univ., Brunswick (Germany, F.R.).
Airborne Collision Avoidance System (ACAS) in controlled air traffic. Aspects of reciprocal influence in Secondary Surveillance Radar (SSR) radio loads
[ETN-91-99253] p 644 N91-23105

Tel-Aviv Univ. (Israel).
Secondary frequencies in the wake of a circular cylinder with vortex shedding p 620 A91-39736

Teledyne CAE, Toledo, OH.
Small Engine Component Technology (SECT) study
[NASA-CR-175079] p 663 N91-24208
Model 320-2: A compact advanced UAV turbojet
p 663 N91-24292

Teledyne/McCormick Selph, Hollister, CA.
Helicopter in-flight stores jettison p 671 A91-39389

Test Squadron (6510th), Edwards AFB, CA.
B-1B high AOA testing in the evaluation of a stall inhibitor system p 651 N91-23126

Texas A&M Univ., College Station.
Flexural waves induced by electro-impulse deicing forces p 676 A91-38776
An initial investigation into methods of computing transonic aerodynamic sensitivity coefficients
[NASA-CR-188192] p 629 N91-24099

Texas Univ., Arlington.
Inception length to a fully developed, fin-generated, shock-wave, boundary-layer interaction
p 617 A91-37842

Thomas (Dieter), Fuerstenfeldbruck (Germany, F.R.).
The art of flying qualities testing p 649 N91-23109

Toronto Univ., Downsview (Ontario).
Performance characteristics of hypersonic detonation wave ramjets p 659 N91-23168
Turbulence Prediction Systems, Boulder, CO.
Status of turbulence Prediction System's AWAS 3
p 637 N91-24146

U

United Technologies Corp., West Palm Beach, FL.
Mechanical component diagnostic system
[AD-A232126] p 656 N91-23146
United Technologies Research Center, East Hartford, CT.
Temporally and spatially resolved flow in a two-stage axial compressor. II - Computational assessment
[ASME PAPER 90-GT-299] p 620 A91-39048
Unified aeroacoustics analysis for high speed turboprop aerodynamics and noise. Volume 2: Development of theory for wing shielding
[NASA-CR-185192] p 688 N91-23849
Notched fatigue of single crystal PWA 1480 at turbine attachment temperatures p 682 N91-24310

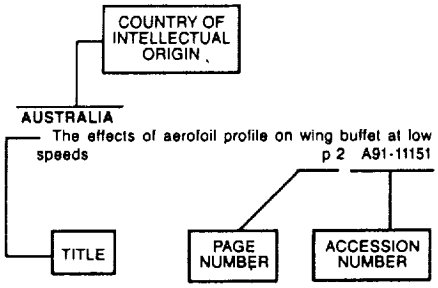
V

Vigyan Research Associates, Inc., Hampton, VA.
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 1: Steady
[AD-A233482] p 631 N91-24113
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 2: User manual for VORSTAB-2
[AD-A233483] p 631 N91-24114
Calculation of high angle of attack aerodynamics of fighter configurations. Volume 3: Unsteady
[AD-A233569] p 631 N91-24115
Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).
Aero-thermal investigation of a highly loaded transonic linear turbine guide vane cascade. A test case for inviscid and viscous flow computations
[VKI-TN-174] p 680 N91-23437

W

Westinghouse Defense and Electronic Systems Center, Baltimore, MD.
Saberliner flight test for airborne wind shear forward looking detection and avoidance radar systems
p 637 N91-24149
Wichita State Univ., KS.
Water droplet impingement on airfoils and aircraft engine inlets for icing analysis p 634 A91-38543
Kansas Aviation Review
[NIAR-91-3] p 613 N91-24087
Evaluation of automation for inspection of aging aircraft p 613 N91-24088
An overview of information resources in aviation
p 690 N91-24091
Program plans for aviation safety research
[NIAR-90-32] p 638 N91-24157
Feasibility study in crack detection in aircraft stiffened panels by pulse probing and deconvolution
p 654 N91-24158
Bonded/fusion repair of aircraft structures
p 613 N91-24160
Crashworthiness experiments p 638 N91-24161
Mechanical paint removal techniques for composite aircraft p 613 N91-24163
Williams International, Walled Lake, MI.
Small Engine Component Technology (SECT) studies
[NASA-CR-175080] p 663 N91-24206
Wright Research Development Center, Wright-Patterson AFB, OH.
The handling qualities of the STOL and maneuver technology demonstrator from specification to flight test
p 666 N91-23117
Turbojet potential for hypersonic flight
p 658 N91-23155
An experimental evaluation of combustor liner materials for solid fuel ramjet testing p 670 N91-24289
Analytical certification of aircraft structures
p 684 N91-24641
Wright State Univ., Dayton, OH.
A computer aided multivariable control systems design technique with application to aircraft flying qualities
[AD-A232549] p 653 N91-23144

Typical Foreign Technology Index Listing



Listings in this index are arranged alphabetically by country of intellectual origin. The title of the document is used to provide a brief description of the subject matter. The page number and the accession number are included in each entry to assist the user in locating the citation in the abstract section. If applicable, a report number is also included as an aid in identifying the document.

B

BELGIUM

Aero-thermal investigation of a highly loaded transonic linear turbine guide vane cascade. A test case for inviscid and viscous flow computations
[VKI-TN-174] p 680 N91-23437

C

CANADA

Decoupled flight control via a model-following technique using the Euler operator p 664 A91-37595

Moving surface boundary-layer control as applied to two-dimensional airfoils p 615 A91-37768

Actual stresses in notches - How applicable are the common stress concentration factors?
p 676 A91-38775

An update on SKAD (survival kit air droppable) systems p 635 A91-39384

406 MHz ELT signal spectra for Sarsat
p 643 A91-39778

Tiltrotor developments p 612 A91-40180

An initial study into the influence of control stick characteristics on the handling qualities of a fly-by-wire helicopter p 651 N91-23122

An investigation into the use of side-arm control for civil rotorcraft applications p 667 N91-23123

Determination of decision-height windows for decelerating IMC approaches in helicopters
p 667 N91-23124

Performance characteristics of hypersonic detonation wave ramjets p 659 N91-23168

The role of analysis in the design and qualification of composite aircraft structures p 684 N91-24648

CHINA, PEOPLE'S REPUBLIC OF

A new method for estimating airspeed, attack angle and sideslip angle p 664 A91-37051

The planar elements method for computing the scattering field of flight vehicle p 674 A91-37052

CAPP imitative system of aircraft assembly
p 611 A91-37061

Experimental investigation on supersonic combustion
p 657 A91-38203

Cycle analysis for a supersonic through flow fan engine p 657 A91-38207

On digital electronic control system of aircraft engine
p 657 A91-38209

Flow around an unsteady thin wing close to curved ground p 620 A91-39744

Synchronous iterative method for computation of vortex flows at high angles of attack p 624 A91-40126

The transient dynamic performances of a rotor-SFDB system during passage through resonance
p 678 A91-40130

The design and simulation of an intelligent flight control system p 665 A91-40133

Transonic analysis and design using an improved grid
p 624 A91-40137

Air surveying and data analysis for dynamic response of missiles at swept-back wing tip p 647 A91-40156

Modal analysis for fibre-carbon composite parts of an airplane p 679 A91-40157

The nonlinear dynamic response analysis of the front windshield of Y12 under 'bird-impact' loads
p 648 A91-40158

Application of acoustically treated honeycomb sandwich panels in noise control of aircraft cabin
p 648 A91-40160

Numerical analysis of solid-fuel interactive vibration on an aircraft integral tank p 648 A91-40161

Calculation and experimental study on sonic fatigue life of aircraft structural panels p 648 A91-40162

Further research on mechanical model for 'ground resonance' of helicopters p 665 A91-40164

Vibration problems in an aircraft design
p 648 A91-40165

Similarities and differences between environment tests and reliability tests in view of vibration
p 665 A91-40166

Application of identification method of modal parameters to flight flutter test p 665 A91-40167

Integration of vibration test and flutter analysis - A brief introduction to 'a real-time flutter analysis system'
p 665 A91-40168

Transonic flutter analysis of 2-D airfoils with 2 degrees of freedom p 665 A91-40169

Identification of nacelle modes from airplane GVT results p 648 A91-40170

A study on sonic load of the vertical tail of F-7 aircraft
p 648 A91-40171

Flexure vibration test method of aviation tube
p 648 A91-40172

A numerical method for simulating drop test of landing gears p 648 A91-40174

Prediction of test spectrum for gunfire vibration
p 666 A91-40175

A new pseudo-potential function model for rotational flow and its application to transonic-supersonic flow
p 625 A91-40373

Computation of three-dimensional flow fields through compressor blade rows p 625 A91-40375

Some analysis of decision-making in the test manufacture of military aircraft
[AD-A233111] p 613 N91-24093

Design and implementation of real-time computer coordinated force actuating system with multi-input/output
[AD-A233114] p 687 N91-24768

E

EGYPT

Heat transfer in oscillating flows p 676 A91-38698

F

FRANCE

Aeronautical meteorology - Safety and economics of commercial air transports p 685 A91-38323

A new system for unsteady aerodynamics of moving wall p 618 A91-38695

A model for the experimental study of curvature effects on transition of the boundary layer on a swept wing - Preliminary results p 620 A91-39691

Quantitative analysis of flow visualizations in ONERA water tunnels p 677 A91-39694

Stream functions for the hypersonic flow around quasi-pointed slender bodies at low angles of attack
p 621 A91-39832

Laminar-turbulent transition; Proceedings of the IUTAM Symposium, Ecole Nationale Superieure de l'Aeronautique et de l'Espace, Toulouse, France, Sept. 11-15, 1989
p 677 A91-39901

Experimental and theoretical analysis of natural transition on 'infinite' swept wing p 621 A91-39927

Theoretical study of Goertler vortices - Linear stability approach p 623 A91-39950

Boundary layer tripping in supersonic flow
p 623 A91-39960

Flying Qualities
[AGARD-CP-508] p 649 N91-23108

Hypersonic Combined Cycle Propulsion
[AGARD-CP-479] p 657 N91-23147

A study of supersonic and hypersonic ramjet engines in France from 1950 to 1974 (application on combined cycle aircraft engines) p 658 N91-23149

Comparative study of different systems of combined cycle propulsion p 658 N91-23152

Compact heat exchanger for an inverse components engine p 659 N91-23157

Supersonic-hypersonic inlet studies for aerospaceplane p 659 N91-23160

Integration of propulsive systems: Selection and compromise
[REPT-911-111-101] p 661 N91-23187

The certification of the aircraft integrated propulsive system
[REPT-911-111-102] p 661 N91-23188

The electrical flight control system of A320 Airbus: A fault tolerant system
[REPT-911-111-103] p 667 N91-23192

Observatory of new materials. Evolution perspectives for the materials used in civil transportation aircraft
[REPT-911-111-107] p 672 N91-23248

Oxidation resistant carbon/carbon materials
[REPT-911-430-105] p 672 N91-23251

How to know CMC
[REPT-911-430-130] p 672 N91-23262

Noise inside aircraft fuselages subjected to airborne excitations
[REPT-911-111-104] p 689 N91-23853

AGARD highlights 91/1, March 1991
[AGARD-HIGHLIGHTS-91/1] p 691 N91-24084

LIDAR studies on microbursts p 639 N91-24167

RADAR performance experiments
p 639 N91-24168

MEGASODAR experiment p 639 N91-24169

Analytical Qualification of Aircraft Structures
[AGARD-R-772] p 683 N91-24638

Validation of in-house and external software systems at Aerospatiale p 687 N91-24640

Influence of the refinement of structural calculation on aircraft qualification procedures p 684 N91-24649

AGARD flight test techniques series. Volume 9: Aircraft exterior noise measurement and analysis techniques
[AGARD-AG-300-VOL-9] p 689 N91-24843

G

GERMANY,FEDERAL REPUBLIC OF

Forward sweep - A favorable concept for a laminar flow wing p 615 A91-37767

Equation decoupling - A new approach to the aerodynamic identification of unstable aircraft
p 664 A91-37773

FOREIGN

Orientation measurements and transmission via Mode S at airports p 643 A91-38526
Air travel - System relating flight safety, aircraft, and airports p 634 A91-38527
Canopy breaking system for non-delay pilot rescue p 647 A91-39398
A general method for rotordynamic analysis p 677 A91-39585
Investigations on flow instabilities on airfoils by means of piezofoil-arrays p 621 A91-39911
Instability features appearing on swept wing configurations p 622 A91-39937
Identification strategies for crack shape determination in rotors p 679 A91-40234
Preference for an inertial degree of freedom describing the teeter motion of windturbine and helicopter rotors p 679 A91-40239
Vibration behavior of a labyrinth seal with through-flow p 679 A91-40241
Effects of canard position on the aerodynamic characteristics of a close-coupled canard configuration at low speed p 649 A91-40495
Analysis of numerical solutions for three-dimensional lifting wing flows p 625 A91-40498
Procedure for determination of three-dimensional wind tunnel wall interferences and wall adaptation in compressible subsonic flow using measured wall pressures
[DLR-FB-90-46] p 628 N91-23088
Flight mechanics/air navigation research field. A 1990 Scientific report of the German Air and Space Research Organization
[ISSN-0720-7808] p 643 N91-23103
Airborne Collision Avoidance System (ACAS) in controlled air traffic. Aspects of reciprocal influence in Secondary Surveillance Radar (SSR) radio loads
[ETN-91-99253] p 644 N91-23105
The art of flying qualities testing p 649 N91-23109
Development of MIL-8785C into a handling qualities specification for a new European fighter aircraft p 665 N91-23114
Handling qualities of highly augmented unstable aircraft summary of an AGARD-FMP working group effort p 666 N91-23116
Integration of handling quality aspects into the aerodynamic design of modern unstable fighters p 667 N91-23125
Handling qualities evaluation for highly augmented helicopters p 651 N91-23128
X-31A at first flight p 651 N91-23131
The limits of the landing process of aircraft
[DLR-FB-90-49] p 653 N91-23137
Trajectory optimization considerations for ramjet engines p 658 N91-23151
Airbreathing propulsion for space transport: New concepts, special problems and attempts at solutions p 658 N91-23154
Aerodynamics and stabilization of combustion of hydrogen jets injected into subsonic airflow p 629 N91-23164
The 2-D supersonic nozzle design p 660 N91-23176
Evaluation techniques for highly augmented aircraft
[DLR-FB-90-35] p 667 N91-23191
The propagation of acoustic disturbances in the transonic flow fields of wings
[ESA-TT-1126] p 669 N91-23854
Activities report of the DLR
[ISSN-0938-2194] p 691 N91-24086
Analytical methods for the qualification of helicopter structures p 684 N91-24650

I

INDIA
Application of multiple-input/single-output analysis procedures to flight test data p 647 A91-39420
Low-order panel method for internal flows p 625 A91-40225
INTERNATIONAL ORGANIZATION
A320 - First of the computer-age aircraft p 645 A91-36354
European studies to investigate the feasibility of using 1000 ft vertical separation minima above FL 290. I p 642 A91-38217
Current status and future prospects of air traffic control p 642 A91-38322
ISRAEL
Ground resonance of a helicopter with inter-connected blades p 645 A91-36360
Secondary frequencies in the wake of a circular cylinder with vortex shedding p 620 A91-39736
Vectored propulsion, supermaneuverability and robot aircraft p 649 A91-40501
Real time estimation of aircraft angular attitude
[IAITIC-87-1004] p 649 N91-23107
IAI hypersonic wind tunnel
[IAITIC-87-1006] p 668 N91-23194
Computerized system for static and fatigue large scale structural tests: A case study
[IAITIC-87-1007] p 681 N91-23522
ITALY
Evolution of clutter suppression techniques for air traffic control and surveillance radar p 641 A91-37101
Adaptive airborne track while scan p 642 A91-37139
Evaluation of the performance of a RISC based real time data processor in air traffic control radar applications p 642 A91-37145
Variable-property effects in supersonic wedge flow p 616 A91-37832
The LWC parameter - Some experimental results p 685 A91-38388
Flying qualities experience on the AMX aircraft p 650 N91-23112
Metrics for roll response flying qualities p 650 N91-23118
Airbreathing propulsion for transatmospheric flight p 659 N91-23156
Reacting shock waves in hypersonic propulsion applications p 629 N91-23174

J

JAPAN
All solid-state ASR with adaptive pulse Doppler processing p 641 A91-37107
SSR signal discrimination from garbled replies p 642 A91-37121
Track initiation using MHT in dense environments p 674 A91-37141
Mach 4 testing of scramjet inlet models p 615 A91-37418
ACT wind-tunnel experiments of a transport-type wing p 615 A91-37772
Aerodynamic characteristics of slender wing-gap-body combinations p 615 A91-37777
Re-entry flight control of space plane using approximate perfect servo p 664 A91-37778
Improvement of atmospheric flight performance of a space vehicle through sensitivity minimization p 664 A91-37779
A comparison between computation and experiment for flows around airfoil with slat and flap p 616 A91-37780
The development and research on CAD for education on aircraft design p 686 A91-38234
Further experiments on vortex formation around an oscillating and translating airfoil at large incidences p 620 A91-39738
High gain airborne antenna for satellite communications p 643 A91-39776
Cross-flow instability of 3-D boundary layers on a flat plate p 622 A91-39931
Development and interaction of instabilities in the crossflow field p 622 A91-39938
Visual study of boundary layer transition on rotating flat plate p 623 A91-39941
NKK premium quality titanium master alloy p 672 A91-40425
Analysis of circular elastic membrane wings p 625 A91-40472
Modeling for unsteady aerodynamics of rectangular wing in incompressible flow using step responses p 625 A91-40473
Research on aerodynamic control of blade tip clearance flow in air-cooled turbine
[DE91-764223] p 660 N91-23182
Water-cooling technique of high temperature gas turbine blade
[DE91-764238] p 681 N91-23506
JORDAN
Visualization of the flow about a delta wing maneuvering in pitch to very high angle of attack p 618 A91-38684

K

KOREA(SOUTH)
Supersonic flutter analysis of clamped symmetric composite panels using shear deformable finite elements p 675 A91-37847

N

NETHERLANDS
Theoretical and experimental performance of a solid fuel ramjet combustion cycle for hypersonic flight conditions p 660 N91-23170
Evaluation of the qualification of the structure of a passenger aircraft by analysis and full-scale testing p 684 N91-24645

O

OTHER
Toward automating the design of centrifugal impellers p 676 A91-38874

R

ROMANIA (RUMANIA)
On the improvement of the supersonic lifting line theory p 614 A91-36695
New developments in the dynamic aeroelastic stability study of rotor blades p 673 A91-36698
New methods in the theory of subsonic flows past thin airfoil configurations p 614 A91-36699
Wing calculation in supersonic flow by means of the supersonic lifting line theory p 614 A91-36700
The influence of altitude and speed variations over the aircraft flight control response during the longitudinal nonlinear manoeuvres p 664 A91-36722
Aerodynamic calculation of tandem wings in supersonic flow by means of SLLT p 614 A91-36724
Steady linearised aerodynamics. III - Transonic p 620 A91-39223

S

SPAIN
Hypersonic propulsion: Past and present p 657 N91-23148
Nonlinear analysis of composite shear webs with holes and correlation with tests p 684 N91-24642
SWEDEN
On the development of turbulent spots in plane Poiseuille flow p 678 A91-39904
Long time measurements of landing gear loads on SAAB SF-340 commuter aircraft
[FFA-TN-1990-53] p 653 N91-23138
SYRIA
Kinetic study of a homogeneous propellant primary flame, with and without additive p 671 A91-39690

T

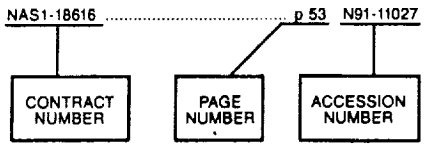
TAIWAN
Numerical investigation of airfoil/jet/fuselage-undersurface flowfields in ground effect p 617 A91-38541
Computation of axisymmetric slender bodies enclosing a jet efflux in pitching oscillatory motion p 618 A91-38681

U

U.S.S.R.
Discontinuous solutions for a three-dimensional hypersonic boundary layer with interaction p 614 A91-37176
Entropy effects of hypersonic flow past blunt delta wings p 615 A91-37181
Detection of traces of water in aviation kerosenes by gas chromatography p 670 A91-37182
Characteristics of the reception by the antenna systems of a descending aircraft of signals from radio-beacon landing systems p 642 A91-37200
Residual stress control in developing processes for the manufacture of compressor blades for gas turbine engines p 674 A91-37269
Evaluation of the phase distortions of the input signal of a synthetic-aperture radar p 677 A91-39144
Functional-adaptive data processing in airborne radio navigation and landing systems p 643 A91-39187
Design and development of aviation gas turbine engines p 657 A91-39201
Sensitivity analysis, optimization, and data support in finite element systems p 677 A91-39230
Boundary layer control by a local heating of the wall p 678 A91-39909
The experimental investigation of stability and receptivity of a swept-wing flow p 623 A91-39944
Receptivity and stability of the boundary layer at a high turbulence level p 678 A91-39945
UNITED KINGDOM
Accent on hypersonic p 669 A91-36625
The introduction of off-line programming techniques for the robotic assembly of aircraft structures
[SME PAPER MS90-276] p 611 A91-36898

US industry enters the green maze
p 685 A91-37049
Fabrication of engineering ceramics by injection molding p 674 A91-37375
The English summer of 1990 - Further progress towards deregulation of the aviation and travel industry
p 690 A91-37801
Air traffic control today and tomorrow
p 642 A91-38215
High subsonic flow about a moving spoiler identifying a novel problem of wind tunnel interference
p 619 A91-38710
Fighter escape system - The next step forward
p 646 A91-39382
Advanced airborne oxygen sensors
p 655 A91-39387
The control of rotor vibration using squeeze-film dampers p 677 A91-39590
The breakdown of the linearized theory and the role of quadrupole sources in transonic rotor acoustics
p 688 A91-39749
Composites for a widebody p 612 A91-39852
Moulded Mustang p 612 A91-39854
Aerodynamics at the speed of sound
p 621 A91-39900
On the instability of hypersonic flow past a wedge
p 621 A91-39922
On the Goertler vortex instability mechanism at hypersonic speeds p 623 A91-39940
The effect of isolated roughness elements on transition in attachment-line flows p 678 A91-39959
Visualisation of boundary layer transition
p 623 A91-39964
Balancing of rotating machinery p 679 A91-40278
The performance of 60 deg delta wings: The effects of leading edge radius on vortex flaps and the wing [CRANFIELD-AERO-9004] p 628 N91-23092
The development of alternate criteria for FBW handling qualities p 666 N91-23113
Handling qualities guidelines for the design of fly-by-wire flight control systems for transport aircraft
p 667 N91-23119
A review of high angle of attack requirements for combat aircraft p 651 N91-23130
The performance of 60 deg delta wings: The effects of leading edge radius and vortex flaps [CRANFIELD-AERO-9002] p 653 N91-23140
Some aspects of shock-wave boundary layer interaction relevant to intake flows p 628 N91-23161
Lightning protection requirements for aircraft: A proposed specification [RAE-TM-FS(F)-632-ISSUE-1-R] p 641 N91-24186
The role of structural analysis in airworthiness certification p 684 N91-24647
Surface activation of Concorde by Be-7
p 690 N91-24983

Typical Contract Number Index Listing

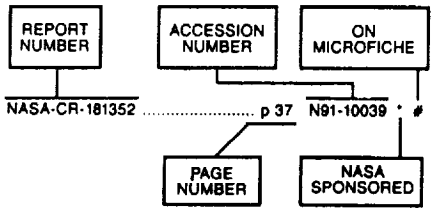


Listings in this index are arranged alphanumerically by contract number. Under each contract number, the accession numbers denoting documents that have been produced as a result of research done under the contract are shown. The accession number denotes the number by which the citation is identified in the abstract section. Preceding the accession number is the page number on which the citation may be found.

AF PROJ. 2307 ..... p 628 N91-23094
p 682 N91-24530
AF PROJ. 2308 ..... p 683 N91-24533
AF PROJECT 2302P101 ..... p 671 A91-39302
AF PROJECT 2302P1 ..... p 671 A91-38812
AF-AFOSR-0155-88 ..... p 683 N91-24533
AF-AFOSR-0177-86 ..... p 628 N91-23094
AF-AFOSR-0373-89 ..... p 682 N91-24530
AF-AFOSR-84-0099 ..... p 617 A91-38680
p 618 A91-38684
AF-AFOSR-86-0082 ..... p 617 A91-37842
AF-AFOSR-86-0090 ..... p 676 A91-38706
AF-AFOSR-86-0112 ..... p 616 A91-37838
AF-AFOSR-87-0074 ..... p 676 A91-38697
AF-AFOSR-89-0042 ..... p 623 A91-39940
AF-ARFOSR-90-0093 ..... p 620 A91-39736
DA PROJ. 1L1-61101-AH-45 ..... p 662 N91-24204
p 662 N91-24205
p 663 N91-24206
p 663 N91-24207
p 663 N91-24208
DA PROJ. 1L1-61102-AH-45 ..... p 660 N91-23179
DA PROJ. 1L1-62211-A-47-A ..... p 681 N91-23513
DA PROJ. 3E1-62787-A-878 ..... p 636 N91-23100
DA PROJ. 3M1-62787-A-878 ..... p 641 N91-24188
DAAG29-82-K-0094 ..... p 663 A91-36358
DAAJ02-87-C-0015 ..... p 656 N91-23146
DAAL03-86-G-0040 ..... p 632 N91-24116
DAAL03-88-C-0003 ..... p 663 A91-36358
DE-AC04-76DP-00789 ..... p 668 A91-40556
p 626 A91-40557
p 627 N91-23085
p 673 N91-24453
DE-AC05-84OR-21400 ..... p 679 N91-23381
DFG-HU-254/8 ..... p 649 A91-40495
DRET-87-272 ..... p 618 A91-38695
DTFA01-87-C-00014 ..... p 652 N91-23134
DTFA01-91-Y-01004 ..... p 640 N91-24185
DTFA03-89-C-00061 ..... p 636 N91-23097
DTFA03-90-C-00050 ..... p 638 N91-24157
FY1455-89-N-0635 ..... p 673 N91-24453
F33601-89-C-0045 ..... p 631 N91-24112
F33615-83-C-3603 ..... p 650 N91-23120
F33615-85-C-5029 ..... p 670 A91-38809
F33615-86-C-5044 ..... p 611 A91-36895
p 673 A91-36896
F33615-87-C-3615 ..... p 653 N91-23144
F33615-87-C-3616 ..... p 631 N91-24113
p 631 N91-24114
p 631 N91-24115
F49620-85-C-0027 ..... p 616 A91-37841
F49620-86-C-0133 ..... p 617 A91-37859
F49620-86-C-0134 ..... p 620 A91-39708
F49620-86-K-0020 ..... p 675 A91-38693
F49620-88-C-0053 ..... p 686 A91-39417
NAG1-1032 ..... p 622 A91-39932
NAG1-1156 ..... p 630 N91-24109
p 631 N91-24110
NAG1-199 ..... p 686 A91-37591
NAG1-732 ..... p 624 A91-40219
NAG1-735 ..... p 624 A91-40215
NAG1-753 ..... p 676 A91-38697
NAG1-793 ..... p 629 N91-24099
NAG1-886 ..... p 615 A91-37769
NAG1-891 ..... p 617 A91-37842
NAG1-8 ..... p 616 A91-37841
NAG1-937 ..... p 622 A91-39932
NAG1-975 ..... p 624 A91-40216
NAG2-484 ..... p 624 A91-40220
NAG2-588 ..... p 627 N91-23084
NAG2-646 ..... p 627 N91-23084
NAG3-284 ..... p 676 A91-38776
NAG3-566 ..... p 634 A91-38543
NAG3-608 ..... p 633 N91-24123
NAG3-621 ..... p 673 A91-36450
NAG3-957 ..... p 683 N91-24563
NAS1-15148 ..... p 672 N91-24358
NAS1-15325 ..... p 634 N91-24139
NAS1-18000 ..... p 686 A91-37591
NAS1-18015 ..... p 626 N91-23080
p 627 N91-23081
NAS1-18029 ..... p 655 A91-39873
NAS1-18036 ..... p 690 N91-24844
NAS1-18107 ..... p 620 A91-39736
p 623 A91-39940
NAS1-18240 ..... p 624 A91-40219
NAS1-18378 ..... p 654 N91-24195
NAS1-18584 ..... p 618 A91-38683
NAS1-18599 ..... p 622 A91-39936
NAS1-18605 ..... p 614 A91-36452
p 620 A91-39736
p 633 N91-24125
NAS1-18703 ..... p 632 N91-24118
p 632 N91-24119
p 632 N91-24120
p 632 N91-24121
p 632 N91-24122
NAS1-18925 ..... p 638 N91-24153
NAS1-19000 ..... p 690 N91-24845
NAS2-12211 ..... p 668 N91-24210
NAS2-12789 ..... p 646 A91-38548
NAS2-13070 ..... p 652 N91-23136
NAS2-13157 ..... p 654 N91-24198
NAS3-23288 ..... p 681 N91-24309
NAS3-23691 ..... p 683 N91-24551
NAS3-23720 ..... p 688 N91-23849
p 688 N91-23850
p 688 N91-23851
p 689 N91-23852
NAS3-23939 ..... p 682 N91-24310
NAS3-23940 ..... p 671 A91-38819
NAS3-24384 ..... p 672 N91-24451
NAS3-24541 ..... p 663 N91-24208
NAS3-24542 ..... p 663 N91-24207
NAS3-24543 ..... p 663 N91-24206
NAS3-24544 ..... p 662 N91-24205
NAS3-24545 ..... p 662 N91-24204
NAS3-25574 ..... p 626 A91-40582
NAS3-25967 ..... p 661 N91-23185
NCA2-192 ..... p 617 A91-37842
NCA2-287 ..... p 617 A91-38680
p 618 A91-38684
NCC2-596 ..... p 617 A91-38680
p 625 A91-40223
NCC2-604 ..... p 669 N91-23195
NCC2-683 ..... p 630 N91-24105
NSERC-A-2181 ..... p 615 A91-37768
NSERC-A-2939 ..... p 676 A91-38775
NSF DMS-88-10150 ..... p 620 A91-39736
N00014-83-C-0434 ..... p 615 A91-37420
N00014-83-K-0239 ..... p 617 A91-38545
N00014-85-K-0513 ..... p 619 A91-38699
N00014-85-K-0646 ..... p 616 A91-37830
N00014-86-K-0754 ..... p 620 A91-39736
505-10-03 ..... p 687 N91-24796
505-59-00 ..... p 654 N91-24198
505-60-11-01 ..... p 634 N91-24132
505-60-21 ..... p 683 N91-24556
505-60-31-01 ..... p 655 N91-24199
505-60-4X ..... p 683 N91-24555
505-60-41-01 ..... p 634 N91-24139
505-61-21-03 ..... p 629 N91-24098
505-61-71 ..... p 630 N91-24108
p 668 N91-24209
505-62-12 ..... p 627 N91-23083
505-62-21 ..... p 683 N91-24551
505-62-52 ..... p 628 N91-23089
p 660 N91-23179
p 679 N91-23409
p 633 N91-24130
p 633 N91-24131
505-62-71 ..... p 662 N91-24201
505-63-1A ..... p 672 N91-24451
505-63-36 ..... p 681 N91-23513
505-63-50-05 ..... p 672 N91-24358
505-63-50 ..... p 652 N91-23135
p 654 N91-24196
505-64-12 ..... p 636 N91-24140
p 639 N91-24166
505-66-21-03 ..... p 655 N91-24200
505-66-71 ..... p 668 N91-24210
505-67-21 ..... p 636 N91-23099
505-68-10 ..... p 628 N91-23086
p 628 N91-23087
505-68-11 ..... p 661 N91-23183
p 661 N91-23184
505-68-30 ..... p 633 N91-24123
505-90-52-01 ..... p 633 N91-24125
506-40-41-02 ..... p 669 N91-24211
506-49-11-01 ..... p 626 N91-23080
p 627 N91-23081
532-06-21 ..... p 687 N91-24757
532-06-37 ..... p 652 N91-23136
533-02-11 ..... p 633 N91-24128
533-02-51 ..... p 652 N91-23133
535-03-01 ..... p 688 N91-23849
p 688 N91-23850
p 688 N91-23851
p 689 N91-23852
p 630 N91-24107
535-03-10-01 ..... p 632 N91-24118
p 632 N91-24119
p 632 N91-24120
p 632 N91-24121
p 632 N91-24122
535-03-11-04 ..... p 690 N91-24844
535-05-01 ..... p 662 N91-24204
p 662 N91-24205
p 663 N91-24206
p 663 N91-24207
p 663 N91-24208
537-01-02-01 ..... p 654 N91-24195
537-01-11 ..... p 662 N91-24203
537-02-00 ..... p 636 N91-23098
537-02-21 ..... p 661 N91-23185
p 662 N91-24202
537-03-20 ..... p 690 N91-24845

CONTRACT

Typical Report Number Index Listing



Listings in this index are arranged alphanumerically by report number. The page number indicates the page on which the citation is located. The accession number denotes the number by which the citation is identified. An asterisk (*) indicates that the item is a NASA report. A pound sign (#) indicates that the item is available on microfiche.

A-90144 ..... p 630 N91-24108 * #
A-90182 ..... p 687 N91-24757 * #
A-90184 ..... p 636 N91-23099 * #
A-90247 ..... p 666 N91-24209 * #
A-91158 ..... p 654 N91-24198 * #

AD-A231658 ..... p 626 N91-23079 #
AD-A232023 ..... p 681 N91-23554 #
AD-A232024 ..... p 653 N91-23141 #
AD-A232055 ..... p 656 N91-23145 #
AD-A232101 ..... p 680 N91-23445 #
AD-A232126 ..... p 656 N91-23146 #
AD-A232422 ..... p 653 N91-23143 #
AD-A232549 ..... p 653 N91-23144 #
AD-A232660 ..... p 613 N91-23076 #
AD-A232661 ..... p 613 N91-23077 #
AD-A232668 ..... p 644 N91-23106 #
AD-A232671 ..... p 669 N91-23198 #
AD-A232714 ..... p 628 N91-23094 #
AD-A232723 ..... p 636 N91-23100 #
AD-A232793 ..... p 673 N91-24453 #
AD-A232871 ..... p 669 N91-23199 #
AD-A232902 ..... p 682 N91-24530 #
AD-A232907 ..... p 641 N91-24187 #
AD-A233040 ..... p 654 N91-24197 #
AD-A233066 ..... p 683 N91-24533 #
AD-A233111 ..... p 613 N91-24093 #
AD-A233114 ..... p 687 N91-24768 #
AD-A233161 ..... p 631 N91-24111 #
AD-A233201 ..... p 631 N91-24112 #
AD-A233349 ..... p 641 N91-24188 #
AD-A233482 ..... p 631 N91-24113 #
AD-A233483 ..... p 631 N91-24114 #
AD-A233569 ..... p 631 N91-24115 #
AD-A233584 ..... p 632 N91-24116 #
AD-A233712 ..... p 641 N91-24186 #

AD-E501359 ..... p 613 N91-23076 #
AD-E501360 ..... p 613 N91-23077 #

AEDC-TR-90-21 ..... p 680 N91-23445 #

AFOSR-91-0139TR ..... p 628 N91-23094 #
AFOSR-91-0165TR ..... p 683 N91-24533 #
AFOSR-91-0184TR ..... p 682 N91-24530 #

AGARD-AG-300-VOL-9 ..... p 689 N91-24843 #

AGARD-CP-479 ..... p 657 N91-23147 #
AGARD-CP-508 ..... p 649 N91-23108 #

AGARD-HIGHLIGHTS-91/1 ..... p 691 N91-24084 #

AGARD-R-772 ..... p 683 N91-24638 #

AIAA PAPER 90-2268 ..... p 626 A91-40561 * #
AIAA PAPER 91-0838 ..... p 670 A91-40555 #
AIAA PAPER 91-0858 ..... p 668 A91-40556 #
AIAA PAPER 91-0875 ..... p 626 A91-40557 #
AIAA PAPER 91-0880 ..... p 635 A91-40558 #
AIAA PAPER 91-0889 ..... p 635 A91-40559 #
AIAA PAPER 91-0909 ..... p 612 A91-40563 #
AIAA PAPER 91-1104 ..... p 626 A91-40562 * #

AIAA-90-0098 ..... p 659 N91-23158 #
AIAA-91-1758 ..... p 633 N91-24130 * #
AIAA-91-1902 ..... p 662 N91-24201 * #
AIAA-91-2458 ..... p 662 N91-24202 * #
AIAA-91-2460 ..... p 661 N91-23185 * #
AIAA-91-2463 ..... p 662 N91-24203 * #
AIAA-91-2474 ..... p 633 N91-24131 * #

ARO-23758.2-EG-F ..... p 632 N91-24116 #

ASME PAPER 90-GT-299 ..... p 620 A91-39048 * #

AVSCOM-TR-86-C-10 ..... p 663 N91-24208 * #
AVSCOM-TR-86-C-11 ..... p 662 N91-24205 * #
AVSCOM-TR-86-C-12 ..... p 662 N91-24204 * #
AVSCOM-TR-86-C-8 ..... p 663 N91-24207 * #
AVSCOM-TR-86-C-9 ..... p 663 N91-24206 * #
AVSCOM-TR-90-C-012 ..... p 660 N91-23179 * #
AVSCOM-TR-90-C-033 ..... p 681 N91-23513 * #
AVSCOM-TR-90-D-24 ..... p 656 N91-23146 #

BR116373 ..... p 641 N91-24186 #

CONF-9104171-7 ..... p 627 N91-23085 #

CRANFIELD-AERO-9002 ..... p 653 N91-23140 #
CRANFIELD-AERO-9004 ..... p 628 N91-23092 #

CRIE-T-89059 ..... p 681 N91-23506 #

DE91-009743 ..... p 679 N91-23381 #
DE91-009764 ..... p 627 N91-23085 #
DE91-764223 ..... p 660 N91-23182 #
DE91-764238 ..... p 681 N91-23506 #

DLR-FB-88-13 ..... p 689 N91-23854 #
DLR-FB-90-35 ..... p 667 N91-23191 #
DLR-FB-90-46 ..... p 628 N91-23088 #
DLR-FB-90-49 ..... p 653 N91-23137 #

DOT-FAA/CT-TN90/55 ..... p 644 N91-24190 #

DOT-VNTSC-FAA-90-6 ..... p 626 N91-23079 #
DOT-VNTSC-FAA-90-7 ..... p 631 N91-24111 #

DOT/FAA/CT-TN90/48 ..... p 644 N91-23106 #

DOT/FAA/CT-90/21 ..... p 636 N91-23097 #

DOT/FAA/RD-90-30 ..... p 631 N91-24111 #
DOT/FAA/RD-90/29 ..... p 626 N91-23079 #
DOT/FAA/RD-91/2-PT-1 ..... p 639 N91-24166 * #
DOT/FAA/RD-91/2-PT-2 ..... p 636 N91-24140 * #
DOT/FAA/RD-91/5 ..... p 669 N91-23196 #
DOT/FAA/RD-91/7 ..... p 652 N91-23134 #

DOT/FAA/SE-91/1 ..... p 640 N91-24185 #

D6-54961 ..... p 634 N91-24139 * #

E-5583 ..... p 660 N91-23179 * #
E-5933 ..... p 630 N91-24107 * #
E-6013 ..... p 661 N91-23183 * #
E-6085 ..... p 681 N91-23513 * #
E-6093 ..... p 679 N91-23409 * #
E-6131 ..... p 662 N91-24201 * #
E-6136 ..... p 661 N91-23184 * #
E-6158 ..... p 626 N91-23086 * #
E-6159 ..... p 636 N91-23098 * #
E-6164 ..... p 628 N91-23087 * #
E-6179 ..... p 687 N91-24796 * #
E-6226 ..... p 627 N91-23083 * #
E-6233 ..... p 628 N91-23089 * #
E-6238 ..... p 661 N91-23185 * #
E-6239 ..... p 662 N91-24202 * #
E-6256 ..... p 662 N91-24203 * #
E-6275 ..... p 633 N91-24131 * #
E-6318 ..... p 633 N91-24130 * #

EDR-12422 ..... p 663 N91-24207 * #

ESA-TT-1126 ..... p 689 N91-23854 #

ETN-91-99063 ..... p 667 N91-23191 #
ETN-91-99067 ..... p 628 N91-23088 #
ETN-91-99069 ..... p 653 N91-23137 #
ETN-91-99079 ..... p 643 N91-23103 #
ETN-91-99107 ..... p 653 N91-23138 #
ETN-91-99114 ..... p 680 N91-23437 #
ETN-91-99252 ..... p 691 N91-24088 #
ETN-91-99253 ..... p 644 N91-23105 #
ETN-91-99265 ..... p 661 N91-23187 #
ETN-91-99266 ..... p 661 N91-23188 #
ETN-91-99267 ..... p 667 N91-23192 #
ETN-91-99268 ..... p 689 N91-23853 #
ETN-91-99271 ..... p 672 N91-23248 #
ETN-91-99277 ..... p 672 N91-23251 #
ETN-91-99302 ..... p 672 N91-23262 #
ETN-91-99312 ..... p 689 N91-23854 #
ETN-91-99331 ..... p 641 N91-24186 #
ETN-91-99332 ..... p 653 N91-23140 #
ETN-91-99333 ..... p 628 N91-23092 #

FFA-TN-1990-53 ..... p 653 N91-23138 #

FSCM-24235 ..... p 663 N91-24206 * #

FTD-ID(RS)T-0166-90 ..... p 687 N91-24768 #
FTD-ID(RS)T-0716-90 ..... p 613 N91-24093 #

GARRETT-21-5776-2A ..... p 662 N91-24205 * #

H-1489 ..... p 668 N91-24210 * #
H-1531 ..... p 683 N91-24556 * #
H-1547 ..... p 633 N91-24128 * #
H-1565 ..... p 683 N91-24555 * #
H-1687 ..... p 652 N91-23133 * #

IAITIC-87-1004 ..... p 649 N91-23107 #
IAITIC-87-1006 ..... p 668 N91-23194 #
IAITIC-87-1007 ..... p 681 N91-23522 #

ICASE-91-40 ..... p 633 N91-24125 * #

IDA-P-2401 ..... p 613 N91-23077 #
IDA-P-2462 ..... p 613 N91-23076 #

IDA/HQ-90-35536 ..... p 613 N91-23077 #
IDA/HQ-90-35834 ..... p 613 N91-23076 #

ISBN-1-871564-03-4 ..... p 653 N91-23140 #
ISBN-1-871564-05-0 ..... p 628 N91-23092 #
ISBN-92-835-0594-8 ..... p 657 N91-23147 #
ISBN-92-835-0602-2 ..... p 649 N91-23108 #
ISBN-92-835-0603-0 ..... p 683 N91-24638 #
ISBN-92-835-0612-X ..... p 689 N91-24843 #

ISSN-0171-1342 ..... p 628 N91-23088 #
ISSN-0720-7808 ..... p 643 N91-23103 #
ISSN-0938-2194 ..... p 691 N91-24088 #
ISSN-0939-2963 ..... p 653 N91-23137 #
ISSN-0939-2963 ..... p 667 N91-23191 #

ITN-88-85003 ..... p 649 N91-23107 #
ITN-88-85005 ..... p 668 N91-23194 #
ITN-88-85006 ..... p 681 N91-23522 #

L-16502-VOL-2 ..... p 634 N91-24132 * #
L-16509 ..... p 655 N91-24199 * #
L-16774 ..... p 629 N91-24098 * #

LMSC-F-415048 ..... p 636 N91-24141 * #

LR-31879 ..... p 690 N91-24844 * #

LU-AFOSR-FR-90 ..... p 628 N91-23094 #

REPORT

LYC-86-11 ..... p 662 N91-24204 * #

L9KVAE-FR-91001 ..... p 652 N91-23136 * #

MTL-TR-91-3 ..... p 681 N91-23554 #

NAL-TM-620 ..... p 660 N91-23182 #

NAS 1.15:101698 ..... p 633 N91-24128 * #
NAS 1.15:101701 ..... p 683 N91-24555 * #
NAS 1.15:101712 ..... p 683 N91-24556 * #
NAS 1.15:101735 ..... p 652 N91-23133 * #
NAS 1.15:102817 ..... p 630 N91-24108 * #
NAS 1.15:102831 ..... p 687 N91-24757 * #
NAS 1.15:102832 ..... p 636 N91-23099 * #
NAS 1.15:102853 ..... p 668 N91-24209 * #
NAS 1.15:103757 ..... p 661 N91-23183 * #
NAS 1.15:103797 ..... p 681 N91-23513 * #
NAS 1.15:103801 ..... p 679 N91-23409 * #
NAS 1.15:104073 ..... p 652 N91-23135 * #
NAS 1.15:104074 ..... p 654 N91-24196 * #
NAS 1.15:104351 ..... p 661 N91-23184 * #
NAS 1.15:104356 ..... p 660 N91-23179 * #
NAS 1.15:104362 ..... p 628 N91-23086 * #
NAS 1.15:104363 ..... p 636 N91-23098 * #
NAS 1.15:104366 ..... p 628 N91-23087 * #
NAS 1.15:104374 ..... p 687 N91-24796 * #
NAS 1.15:104377 ..... p 630 N91-24107 * #
NAS 1.15:104403 ..... p 627 N91-23083 * #
NAS 1.15:104407 ..... p 628 N91-23089 * #
NAS 1.15:104411 ..... p 661 N91-23185 * #
NAS 1.15:104412 ..... p 662 N91-24202 * #
NAS 1.15:104423 ..... p 662 N91-24203 * #
NAS 1.15:104436 ..... p 633 N91-24131 * #
NAS 1.15:104437 ..... p 662 N91-24201 * #
NAS 1.15:104469 ..... p 633 N91-24130 * #
NAS 1.15:4267 ..... p 629 N91-24098 * #
NAS 1.26:175077 ..... p 662 N91-24204 * #
NAS 1.26:175078 ..... p 662 N91-24205 * #
NAS 1.26:175079 ..... p 663 N91-24208 * #
NAS 1.26:175080 ..... p 663 N91-24206 * #
NAS 1.26:175081 ..... p 663 N91-24207 * #
NAS 1.26:177578 ..... p 652 N91-23136 * #
NAS 1.26:177586 ..... p 654 N91-24198 * #
NAS 1.26:179432 ..... p 668 N91-24210 * #
NAS 1.26:181918 ..... p 634 N91-24139 * #
NAS 1.26:181924-VOL-1 ..... p 632 N91-24118 * #
NAS 1.26:181924-VOL-2 ..... p 632 N91-24119 * #
NAS 1.26:182075 ..... p 690 N91-24844 * #
NAS 1.26:182076 ..... p 626 N91-23080 * #
NAS 1.26:182077 ..... p 627 N91-23081 * #
NAS 1.26:182109 ..... p 683 N91-24551 * #
NAS 1.26:182289 ..... p 672 N91-24451 * #
NAS 1.26:185192 ..... p 688 N91-23849 * #
NAS 1.26:185193 ..... p 688 N91-23850 * #
NAS 1.26:185194 ..... p 688 N91-23851 * #
NAS 1.26:185195 ..... p 689 N91-23852 * #
NAS 1.26:186769 ..... p 669 N91-23195 * #
NAS 1.26:187098 ..... p 633 N91-24123 * #
NAS 1.26:187478 ..... p 672 N91-24358 * #
NAS 1.26:187484-VOL-1 ..... p 632 N91-24120 * #
NAS 1.26:187484-VOL-2 ..... p 632 N91-24121 * #
NAS 1.26:187484-VOL-3 ..... p 632 N91-24122 * #
NAS 1.26:187546 ..... p 690 N91-24845 * #
NAS 1.26:187564 ..... p 633 N91-24125 * #
NAS 1.26:188044 ..... p 630 N91-24105 * #
NAS 1.26:188192 ..... p 629 N91-24099 * #
NAS 1.26:188199 ..... p 627 N91-23084 * #
NAS 1.26:188231 ..... p 631 N91-24110 * #
NAS 1.26:188232 ..... p 683 N91-24583 * #
NAS 1.26:188235 ..... p 630 N91-24109 * #
NAS 1.26:4375 ..... p 654 N91-24195 * #
NAS 1.55:10028 ..... p 655 N91-24200 * #
NAS 1.55:10031 ..... p 669 N91-24211 * #
NAS 1.55:10060-PT-1 ..... p 639 N91-24166 * #
NAS 1.55:10060-PT-2 ..... p 636 N91-24140 * #
NAS 1.55:3020-VOL-2 ..... p 634 N91-24132 * #
NAS 1.60:2888 ..... p 655 N91-24199 * #
NAS 1.71:ARC-11909-1 ..... p 635 N91-23095 * #
NAS 1.71:LAR-13563-1 ..... p 679 N91-23410 * #
NAS 1.71:LEW-15094-1 ..... p 660 N91-23180 * #

NASA-CASE-ARC-11909-1 ..... p 635 N91-23095 * #

NASA-CASE-LAR-13563-1 ..... p 679 N91-23410 * #

NASA-CASE-LEW-15094-1 ..... p 660 N91-23180 * #

NASA-CP-10028 ..... p 655 N91-24200 * #
NASA-CP-10031 ..... p 669 N91-24211 * #
NASA-CP-10060-PT-1 ..... p 639 N91-24166 * #
NASA-CP-10060-PT-2 ..... p 636 N91-24140 * #
NASA-CP-3020-VOL-2 ..... p 634 N91-24132 * #

NASA-CR-175077 ..... p 662 N91-24204 * #
NASA-CR-175078 ..... p 662 N91-24205 * #
NASA-CR-175079 ..... p 663 N91-24208 * #
NASA-CR-175080 ..... p 663 N91-24206 * #
NASA-CR-175081 ..... p 663 N91-24207 * #
NASA-CR-177578 ..... p 652 N91-23136 * #
NASA-CR-177586 ..... p 654 N91-24198 * #
NASA-CR-179432 ..... p 668 N91-24210 * #
NASA-CR-181918 ..... p 634 N91-24139 * #
NASA-CR-181924-VOL-1 ..... p 632 N91-24118 * #
NASA-CR-181924-VOL-2 ..... p 632 N91-24119 * #
NASA-CR-182075 ..... p 690 N91-24844 * #
NASA-CR-182076 ..... p 626 N91-23080 * #
NASA-CR-182077 ..... p 627 N91-23081 * #
NASA-CR-182109 ..... p 683 N91-24551 * #
NASA-CR-182289 ..... p 672 N91-24451 * #
NASA-CR-185192 ..... p 688 N91-23849 * #
NASA-CR-185193 ..... p 688 N91-23850 * #
NASA-CR-185194 ..... p 688 N91-23851 * #
NASA-CR-185195 ..... p 689 N91-23852 * #
NASA-CR-186769 ..... p 669 N91-23195 * #
NASA-CR-187098 ..... p 633 N91-24123 * #
NASA-CR-187478 ..... p 672 N91-24358 * #
NASA-CR-187484-VOL-1 ..... p 632 N91-24120 * #
NASA-CR-187484-VOL-2 ..... p 632 N91-24121 * #
NASA-CR-187484-VOL-3 ..... p 632 N91-24122 * #
NASA-CR-187546 ..... p 690 N91-24845 * #
NASA-CR-187564 ..... p 633 N91-24125 * #
NASA-CR-188044 ..... p 630 N91-24105 * #
NASA-CR-188192 ..... p 629 N91-24099 * #
NASA-CR-188199 ..... p 627 N91-23084 * #
NASA-CR-188231 ..... p 631 N91-24110 * #
NASA-CR-188232 ..... p 683 N91-24583 * #
NASA-CR-188235 ..... p 630 N91-24109 * #
NASA-CR-4375 ..... p 654 N91-24195 * #

NASA-TM-101698 ..... p 633 N91-24128 * #
NASA-TM-101701 ..... p 683 N91-24555 * #
NASA-TM-101712 ..... p 683 N91-24556 * #
NASA-TM-101735 ..... p 652 N91-23133 * #
NASA-TM-102817 ..... p 630 N91-24108 * #
NASA-TM-102831 ..... p 687 N91-24757 * #
NASA-TM-102832 ..... p 636 N91-23099 * #
NASA-TM-102853 ..... p 668 N91-24209 * #
NASA-TM-103757 ..... p 661 N91-23183 * #
NASA-TM-103797 ..... p 681 N91-23513 * #
NASA-TM-103801 ..... p 679 N91-23409 * #
NASA-TM-104073 ..... p 652 N91-23135 * #
NASA-TM-104074 ..... p 654 N91-24196 * #
NASA-TM-104351 ..... p 661 N91-23184 * #
NASA-TM-104356 ..... p 660 N91-23179 * #
NASA-TM-104362 ..... p 628 N91-23086 * #
NASA-TM-104363 ..... p 636 N91-23098 * #
NASA-TM-104366 ..... p 628 N91-23087 * #
NASA-TM-104374 ..... p 687 N91-24796 * #
NASA-TM-104377 ..... p 630 N91-24107 * #
NASA-TM-104403 ..... p 627 N91-23083 * #
NASA-TM-104407 ..... p 628 N91-23089 * #
NASA-TM-104411 ..... p 661 N91-23185 * #
NASA-TM-104412 ..... p 662 N91-24202 * #
NASA-TM-104423 ..... p 662 N91-24203 * #
NASA-TM-104436 ..... p 633 N91-24131 * #
NASA-TM-104437 ..... p 662 N91-24201 * #
NASA-TM-104469 ..... p 633 N91-24130 * #
NASA-TM-4267 ..... p 629 N91-24098 * #

NASA-TP-2888 ..... p 655 N91-24199 * #

NIAR-90-32 ..... p 638 N91-24157 #
NIAR-91-3 ..... p 613 N91-24087 #

ORNL/TM-11648 ..... p 679 N91-23381 #

PAPER-91-1053 ..... p 652 N91-23133 * #

PB91-150268 ..... p 644 N91-24189 #

PWA-5930-29 ..... p 683 N91-24551 * #

RAE-TM-FS(F)-632-ISSUE-1-REV p 641 N91-24186 #

REPT-074-021-M-005 ..... p 663 N91-24206 * #
REPT-412U-3181-29 ..... p 655 N91-24200 * #
REPT-911-111-101 ..... p 661 N91-23187 #
REPT-911-111-102 ..... p 661 N91-23188 #
REPT-911-111-103 ..... p 667 N91-23192 #
REPT-911-111-104 ..... p 689 N91-23853 #
REPT-911-111-107 ..... p 672 N91-23248 #
REPT-911-430-105 ..... p 672 N91-23251 #
REPT-911-430-130 ..... p 672 N91-23262 #

SAND-90-2178C ..... p 627 N91-23085 #

SER-701-640 ..... p 656 N91-23146 #

SME PAPER EM90-178 ..... p 611 A91-36944
SME PAPER EM90-438 ..... p 611 A91-36875
SME PAPER EM90-489 ..... p 645 A91-36942
SME PAPER EM90-665 ..... p 645 A91-36940

SME PAPER MS90-276 ..... p 611 A91-36898
SME PAPER MS90-280 ..... p 611 A91-36895
SME PAPER MS90-282 ..... p 673 A91-36896
SME PAPER MS90-744 ..... p 673 A91-36943

TAMRF-5802-91-01 ..... p 629 N91-24099 * #

TELEDYNE-CAE-2224 ..... p 663 N91-24208 * #

US-PATENT-APPL-SN-418320 ..... p 635 N91-23095 * #
US-PATENT-APPL-SN-608494 ..... p 679 N91-23410 * #
US-PATENT-APPL-SN-647902 ..... p 660 N91-23180 * #

USAARL-91-5 ..... p 636 N91-23100 #
USAARL-91-6-VOL-1 ..... p 641 N91-24188 #
USAARL-91-6-VOL-2 ..... p 641 N91-24187 #

VKI-TN-174 ..... p 680 N91-23437 #

WES/MP/GL-91-3 ..... p 669 N91-23199 #

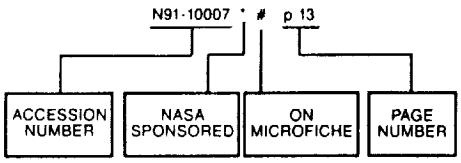
WES/TR/EL-91-2 ..... p 653 N91-23141 #

WL-TM-91-303 ..... p 654 N91-24197 #

WL-TR-91-3033-VOL-1 ..... p 631 N91-24113 #
WL-TR-91-3033-VOL-2 ..... p 631 N91-24114 #
WL-TR-91-3033-VOL-3 ..... p 631 N91-24115 #

WRDC-TR-90-2079-VOL-3 ..... p 673 N91-24453 #
WRDC-TR-90-3069 ..... p 653 N91-23144 #
WRDC-TR-90-3075 ..... p 631 N91-24112 #

Typical Accession Number Index Listing



Listings in this index are arranged alphanumerically by accession number. The page number listed to the right indicates the page on which the citation is located. An asterisk (*) indicates that the item is a NASA report. A pound sign (#) indicates that the item is available on microfiche.

A91-36351 # p 611
A91-36353 # p 611
A91-36354 # p 645
A91-36357 p 645
A91-36358 p 663
A91-36359 p 613
A91-36360 p 645
A91-36450 * p 673
A91-36452 * p 614
A91-36453 * p 614
A91-36625 p 669
A91-36695 # p 614
A91-36698 # p 673
A91-36699 # p 614
A91-36700 # p 614
A91-36722 # p 664
A91-36724 # p 614
A91-36755 p 655
A91-36875 p 611
A91-36895 p 611
A91-36896 p 673
A91-36898 p 611
A91-36940 p 645
A91-36942 p 645
A91-36943 p 673
A91-36944 p 611
A91-37049 p 685
A91-37050 p 645
A91-37051 # p 664
A91-37052 # p 674
A91-37061 # p 611
A91-37094 p 641
A91-37101 p 641
A91-37104 p 685
A91-37106 p 674
A91-37107 p 641
A91-37121 p 642
A91-37139 p 642
A91-37141 p 674
A91-37145 p 642
A91-37176 p 614
A91-37181 p 615
A91-37182 p 670
A91-37200 p 642
A91-37269 p 674
A91-37375 p 674
A91-37410 # p 674
A91-37414 # p 674
A91-37418 # p 615
A91-37419 # p 615
A91-37420 # p 615
A91-37421 * # p 615
A91-37584 p 686
A91-37585 p 686
A91-37591 * p 686
A91-37593 * p 656
A91-37595 p 664
A91-37597 p 664
A91-37598 * p 664
A91-37767 # p 615
A91-37768 # p 615
A91-37769 * # p 615
A91-37770 * # p 615
A91-37771 # p 664
A91-37772 # p 615
A91-37773 # p 664
A91-37774 # p 674
A91-37775 # p 668
A91-37777 # p 615
A91-37778 # p 664
A91-37779 # p 664
A91-37780 # p 616
A91-37801 p 690
A91-37827 * # p 616
A91-37829 * # p 616
A91-37830 # p 616
A91-37832 # p 616
A91-37834 * # p 674
A91-37835 # p 616
A91-37836 # p 616
A91-37838 # p 616
A91-37841 * # p 616
A91-37842 # p 617
A91-37845 * # p 675
A91-37846 # p 675
A91-37847 # p 675
A91-37851 # p 675
A91-37859 # p 617
A91-37880 p 675
A91-37881 # * p 668
A91-38007 p 656
A91-38037 p 657
A91-38127 p 645
A91-38129 p 670
A91-38178 p 657
A91-38203 # p 657
A91-38207 # p 657
A91-38209 # p 657
A91-38215 p 642
A91-38217 p 642
A91-38234 # p 686
A91-38322 p 642
A91-38323 p 685
A91-38367 # p 690
A91-38388 # p 685
A91-38526 p 643
A91-38527 p 634
A91-38541 # p 617
A91-38542 # p 655
A91-38543 * # p 634
A91-38544 * # p 617
A91-38545 # p 617
A91-38546 # p 612
A91-38547 # p 665
A91-38548 * # p 646
A91-38549 # p 646
A91-38550 * # p 646
A91-38577 * # p 643
A91-38580 * # p 612
A91-38677 p 617
A91-38679 p 617
A91-38680 * p 617
A91-38681 p 618
A91-38683 * p 618
A91-38684 * p 618
A91-38686 p 618
A91-38688 p 687
A91-38689 p 675
A91-38693 p 675
A91-38694 p 618
A91-38695 p 618
A91-38697 * p 676
A91-38698 * p 676
A91-38699 p 619
A91-38702 p 619
A91-38706 p 676
A91-38710 p 619
A91-38736 * p 619
A91-38742 p 619
A91-38752 p 646
A91-38775 p 676
A91-38776 * p 676
A91-38787 p 619
A91-38802 p 670
A91-38809 p 670
A91-38812 p 671
A91-38819 * p 671
A91-38863 p 687
A91-38869 p 676
A91-38874 p 676
A91-39048 * # p 620
A91-39144 p 677
A91-39187 p 643
A91-39201 p 657
A91-39223 p 620
A91-39230 p 677
A91-39302 p 671
A91-39377 p 646
A91-39380 p 646
A91-39382 p 646
A91-39384 p 635
A91-39385 p 646
A91-39387 p 655
A91-39389 * p 671
A91-39390 p 647
A91-39392 p 612
A91-39393 p 635
A91-39394 p 647
A91-39395 p 647
A91-39396 p 668
A91-39398 p 647
A91-39401 # p 665
A91-39410 # p 665
A91-39417 # p 686
A91-39420 # p 647
A91-39433 # p 643
A91-39436 # p 686
A91-39585 p 677
A91-39590 p 677
A91-39690 # p 671
A91-39691 # p 620
A91-39694 # p 677
A91-39708 p 620
A91-39736 * p 620
A91-39738 p 620
A91-39744 p 620
A91-39749 p 688
A91-39756 p 643
A91-39776 p 643
A91-39778 p 643
A91-39832 p 621
A91-39852 p 612
A91-39854 p 612
A91-39873 * # p 655
A91-39890 p 656
A91-39900 p 621
A91-39901 p 677
A91-39902 p 677
A91-39904 p 678
A91-39909 p 678
A91-39911 p 621
A91-39919 * p 621
A91-39922 p 621
A91-39927 p 621
A91-39928 p 678
A91-39929 p 621
A91-39931 p 622
A91-39932 * p 622
A91-39933 * p 622
A91-39936 * p 622
A91-39937 p 622
A91-39938 p 622
A91-39940 * p 623
A91-39941 p 623
A91-39944 p 623
A91-39945 p 678
A91-39950 p 623
A91-39956 * p 678
A91-39957 * p 623
A91-39959 p 678
A91-39960 p 623
A91-39964 p 623
A91-40126 # p 624
A91-40130 # p 678
A91-40133 # p 665
A91-40137 # p 624
A91-40156 # p 647
A91-40157 # p 679
A91-40158 # p 648
A91-40160 # p 648
A91-40161 # p 648
A91-40162 # p 648
A91-40164 # p 665
A91-40165 # p 648
A91-40166 # p 665
A91-40167 # p 665
A91-40168 # p 665
A91-40169 # p 665
A91-40170 # p 648
A91-40171 # p 648
A91-40172 # p 648
A91-40174 # p 648
A91-40175 # p 666
A91-40178 p 671
A91-40180 p 612
A91-40181 p 612
A91-40202 p 666
A91-40203 p 648
A91-40215 * # p 624
A91-40216 * # p 624
A91-40217 * # p 624
A91-40218 # p 624
A91-40219 * # p 624
A91-40220 * # p 624
A91-40223 * # p 625
A91-40225 # p 625
A91-40234 p 679
A91-40239 p 679
A91-40241 p 679
A91-40254 # p 649
A91-40278 p 679
A91-40373 # p 625
A91-40375 # p 625
A91-40425 p 672
A91-40472 # p 625
A91-40473 # p 625
A91-40495 p 649
A91-40498 p 625
A91-40501 p 649
A91-40511 p 649
A91-40513 p 625
A91-40517 # p 666
A91-40550 p 656
A91-40555 # p 670
A91-40556 # p 668
A91-40557 # p 626
A91-40558 # p 635
A91-40559 # p 635
A91-40561 * # p 626
A91-40562 * # p 626
A91-40563 # p 612
N91-23076 # p 613
N91-23077 # p 613
N91-23078 # p 626
N91-23079 # p 626
N91-23080 * # p 626
N91-23081 * # p 627
N91-23082 p 627
N91-23083 * # p 627
N91-23084 * # p 627
N91-23085 # p 627
N91-23086 * # p 628
N91-23087 * # p 628
N91-23088 # p 628
N91-23089 * # p 628
N91-23092 # p 628
N91-23094 # p 628
N91-23095 * # p 635
N91-23096 p 635
N91-23097 # p 636
N91-23098 * # p 636
N91-23099 * # p 636
N91-23100 # p 636
N91-23103 # p 643
N91-23105 # p 644
N91-23106 # p 644
N91-23107 # p 649
N91-23108 # p 649
N91-23109 # p 649
N91-23110 # p 650
N91-23111 # p 650
N91-23112 # p 650
N91-23113 # p 666
N91-23114 # p 666
N91-23115 # p 650
N91-23116 # p 666
N91-23117 # p 666
N91-23118 # p 650
N91-23119 # p 667
N91-23120 # p 650
N91-23122 # p 651
N91-23123 # p 667
N91-23124 # p 667
N91-23125 # p 667
N91-23126 # p 651
N91-23127 * # p 651
N91-23128 # p 651
N91-23129 # p 651
N91-23130 # p 651
N91-23131 # p 651
N91-23132 p 652
N91-23133 * # p 652
N91-23134 # p 652
N91-23135 * # p 652
N91-23136 * # p 652
N91-23137 # p 653
N91-23138 # p 653
N91-23140 # p 653
N91-23141 # p 653
N91-23143 # p 653
N91-23144 # p 653
N91-23145 # p 656
N91-23146 # p 656
N91-23147 # p 657
N91-23148 # p 657
N91-23149 # p 658
N91-23150 # p 644
N91-23151 # p 658
N91-23152 # p 658
N91-23153 * # p 658
N91-23154 # p 658
N91-23155 # p 658
N91-23156 # p 659
N91-23157 # p 659
N91-23158 # p 659
N91-23160 # p 659
N91-23161 # p 628
N91-23164 # p 629

N91-23166 # p 659
N91-23168 # p 659
N91-23169 * # p 660
N91-23170 # p 660
N91-23174 # p 629
N91-23175 * # p 629
N91-23176 # p 660
N91-23179 * # p 660
N91-23180 * # p 660
N91-23182 # p 660
N91-23183 * # p 661
N91-23184 * # p 661
N91-23185 * # p 661
N91-23187 # p 661
N91-23188 # p 661
N91-23190 p 667
N91-23191 # p 667
N91-23192 # p 667
N91-23194 # p 668
N91-23195 * # p 669
N91-23198 # p 669
N91-23199 # p 669
N91-23248 # p 672
N91-23251 # p 672
N91-23262 # p 672
N91-23270 p 672
N91-23381 # p 679
N91-23409 * # p 679
N91-23410 * # p 679
N91-23411 p 680
N91-23413 p 680
N91-23419 p 680
N91-23437 # p 680
N91-23445 # p 680
N91-23506 # p 681
N91-23513 * # p 681
N91-23522 # p 681
N91-23554 # p 681
N91-23849 * # p 688
N91-23850 * # p 688
N91-23851 * # p 688
N91-23852 * # p 689
N91-23853 # p 689
N91-23854 # p 689
N91-24074 * # p 681
N91-24078 * # p 689
N91-24084 # p 691
N91-24086 # p 691
N91-24087 # p 613
N91-24088 # p 613
N91-24091 # p 690
N91-24093 # p 613
N91-24098 * # p 629
N91-24099 * # p 629
N91-24103 p 629
N91-24104 p 629
N91-24105 * # p 630
N91-24106 * # p 630
N91-24107 * # p 630
N91-24108 * # p 630
N91-24109 * # p 630
N91-24110 * # p 631
N91-24111 # p 631
N91-24112 # p 631
N91-24113 # p 631
N91-24114 # p 631
N91-24115 # p 631
N91-24116 # p 632
N91-24118 * # p 632
N91-24119 * # p 632
N91-24120 * # p 632
N91-24121 * # p 632
N91-24122 * # p 632
N91-24123 * # p 633
N91-24125 * # p 633
N91-24128 * # p 633
N91-24130 * # p 633
N91-24131 * # p 633
N91-24132 * # p 634
N91-24133 * # p 669
N91-24134 * # p 634
N91-24135 * # p 634
N91-24136 * # p 634
N91-24137 * # p 653
N91-24138 * # p 654
N91-24139 * # p 634
N91-24140 * # p 636
N91-24141 * # p 636
N91-24142 * # p 637
N91-24143 * # p 637
N91-24144 * # p 637
N91-24145 * # p 637
N91-24146 * # p 637
N91-24147 * # p 637
N91-24149 * # p 637
N91-24151 * # p 637
N91-24152 * # p 638
N91-24153 * # p 638
N91-24154 * # p 638
N91-24155 * # p 638
N91-24156 * # p 638
N91-24157 # p 638
N91-24158 # p 654
N91-24160 # p 613
N91-24161 # p 638
N91-24163 # p 613
N91-24166 * # p 639
N91-24167 * # p 639
N91-24168 * # p 639
N91-24169 * # p 639
N91-24170 * # p 685
N91-24172 * # p 639
N91-24173 * # p 639
N91-24174 * # p 639
N91-24175 * # p 639
N91-24176 * # p 640
N91-24177 * # p 640
N91-24178 * # p 640
N91-24179 * # p 640
N91-24180 * # p 640
N91-24182 * # p 640
N91-24183 * # p 640
N91-24184 * # p 640
N91-24185 # p 640
N91-24186 # p 641
N91-24187 # p 641
N91-24188 # p 641
N91-24189 # p 644
N91-24190 # p 644
N91-24195 * # p 654
N91-24196 * # p 654
N91-24197 # p 654
N91-24198 * # p 654
N91-24199 * # p 655
N91-24200 * # p 655
N91-24201 * # p 662
N91-24202 * # p 662
N91-24203 * # p 662
N91-24204 * # p 662
N91-24205 * # p 662
N91-24206 * # p 663
N91-24207 * # p 663
N91-24208 * # p 663
N91-24209 * # p 668
N91-24210 * # p 668
N91-24211 * # p 669
N91-24289 # p 670
N91-24291 # p 686
N91-24292 # p 663
N91-24309 * # p 681
N91-24310 * # p 682
N91-24336 * # p 682
N91-24338 * # p 682
N91-24358 * # p 672
N91-24451 * # p 672
N91-24453 # p 673
N91-24475 # p 682
N91-24530 # p 682
N91-24533 # p 683
N91-24551 * # p 683
N91-24555 * # p 683
N91-24556 * # p 683
N91-24583 * # p 683
N91-24638 # p 683
N91-24640 # p 687
N91-24641 # p 684
N91-24642 # p 684
N91-24643 # p 684
N91-24645 # p 684
N91-24647 # p 684
N91-24648 # p 684
N91-24649 # p 684
N91-24650 # p 684
N91-24652 * # p 685
N91-24757 * # p 687
N91-24768 # p 687
N91-24796 * # p 687
N91-24843 # p 689
N91-24844 * # p 690
N91-24845 * # p 690
N91-24983 * # p 690

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4. Title and Subtitle	5. Report Date
Aeronautical Engineering A Continuing Bibliography (Supplement 269)	September 1991
	6. Performing Organization Code NTT
7. Author(s)	8. Performing Organization Report No.
	10. Work Unit No.
9. Performing Organization Name and Address NASA Scientific and Technical Information Program	11. Contract or Grant No.
	13. Type of Report and Period Covered Special Publication
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